

**DETAILED PROJECT REPORT
FOR
INSTALLATION OF
45 KLPD GRAIN BASED DISTILLERY PLANT
FOR PRODUCTION OF
RECTIFIED SPIRIT OR
EXTRA NEUTRAL ALCOHOL
WITH
STILLAGE EVAPORATION PLANT,
DRYER,
EFFLUENT TREATMENT PLANT,
AND BOILER (18MT/Hr) WITH TG (1.5MW) SET
TO
ACHIEVE ZERO LIQUID DISCHARGE (ZLD)**

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Project profile for installation of 45 KLPD grain based distillery plant to produce Rectified spirit or Extra Neutral Alcohol, alongwith stillage evaporation system, Dryer, Secondary Effluent treatment system, Boiler & TG set

1	Name and Address	M/s. Vitthalrao Shinde Sahakari Sakhar Karkhana Ltd., Gangamainagar, Post. Pimpalner, Tal. Madha, Dist. Solapur
		Phone No.- 02183-233056, 233075, 233076
		Fax No.- 02183-233005
		Email- vs.sugar@gmail.com
2	Constitution and Type	Co-operative Society
3	Project Concept	
	a) New plants	1. 45 KLPD grain based distillery plant to produce Rectified spirit or ENA
		2. Standalone stillage evaporation plant
		3. Dryer
		4. Boiler, 18 MT/hr (45 Kg/cm ²)
		5. TG set 1.50 MW
	b) Products	1. Rectified spirit: IS:323-1959
		2. Extra Neutral Alcohol: IS: 6613-2002
		3. Head spirit conforming to I.S.I. Grade - II, 323 (1959)
		4. DWGS or DDGS
		5. Fusel Oil
		6. Steam: 18 MT/hr, 45 Kg/cm ²
	6. Electricity: 1.80 MW	
	c) Working days /Annum	300
	d) Grain required /Annum	34,085 MT @ 60% of starch
4	Extra Neutral Alcohol or Rectified spirit production /day	42.30KLPD Extra Neutral Alcohol or Rectified spirit 2.70 KLPD Technical Alcohol
	Extra Neutral Alcohol or Rectified spirit production /Annum	a) Extra Neutral Alcohol or Rectified spirit 126.90 Lac Lits./ Annum b) Technical Alcohol - 8.10 Lac Lits./ Annum
5	Steam requirement	Total- 312.80 MT /day (13.03 MT/hr), i.e. For Distillery- 160 MT/day (6.70 MT/hr), MEE & Dryer- 86 MT/day (3.58 MT/hr) and Boiler de-aerator – 67.50 MT/day (2.81MT/hr).
6	Electricity requirement for Distillery, Stillage evaporation plant & Dryer, Secondary ETP, boiler and plant lightning etc.	Max. 27,360 Kwh/day (1.14 MW/hr)
7	Water requirement	3.90 M ³ /day (After recycle of stillage condensate)
8	Staff and workers	Total 93 employees out of which 67 shall be skilled staff and 26 shall be unskilled staff.

9	Financial pattern for proposed project	
	a) Own Contribution of the sugar mill, (25 %)	Rs. 1,633.21 Lac
	b) Term loan from Bank, (75 %)	Rs. 4,899.61 Lac
	Total	Rs. 6,532.82 Lac
10	Capacity Utilization of Distillery plant	100 %
a	Internal Rate of Return (IRR)	13.73 %
b	Break-Even Point (BEP)	76.58 %
c	Payback Period (PBP)	4 years
d	Debt Service Coverage Ratio (DSCR)	
	Average	1.65
	Maximum	2.09
	Minimum	1.25



Vitthalrao Shinde Sahakari Sakhar Karkhana Ltd.,
Gangamainagar, Post. Pimpalner,
Tal. Madha, Dist. Solapur

BOARD OF DIRECTORS

Sr. No.	Name	Designation
1	Hon. Shri. Babanrao Vitthalrao Shinde (M.L.A.)	Founder Chairman
2	Shri. Pandurang Anna Patil	Vice Chairman
3	Shri. Maruti Vishwanath Bagal	Director
4	Shri. Nilkanth Bhagwan Patil	Director
5	Shri. Sitaram Limbraj Gaikawad	Director
6	Shri. Prabhakar Gangadhar Kute	Director
7	Shri. Baban Pandurang Patil	Director
8	Shri. Ramesh Venkyatrao Yewale	Director
9	Shri. Bhaurao Bhanudas Tarange	Director
10	Shri. Vishnu Mahadeo Humbe	Director
11	Shri. Shivaji Mahadeo Doke	Director
12	Shri. Popat Digambar Gaikawad	Director
13	Shri. Amol Saudagar Chavan	Director
14	Shri. Ranjitsinh Babanrao Shinde	Director
15	Shri. Vetala Jalindhar Jadhav	Director
16	Shri. Gautam Maruti More	Director
17	Shri. Laxman Ramdas Khupase	Director
18	Shri. Balasaheb Annasaheb Dhavale	Director
19	Sau. Nandatai Baburao Surve	Director
20	Sau. Sindhutai Subhash Nagtilak	Director
21	Shri. Vamanrao Pralhad Ubale	Director
22	Shri. Popat Balbhim Chavan	Director
23	Shri. Ramchandra Dhula Takale	Director
24	Shri. Rajendrakumar Suryakant Ranaware	Managing Director



CHAPTER - I: INTRODUCTION

Vitthalrao Shinde Sahakari Sakhar Karkhana Limited, is located about 7 kms away from Mumbai- Hyderabad National Highway No. 65 at Gangamainagar, Post Pimpalner, Tal. Madha, Dist. Solapur. Nearest railway station is Kurduwadi. The sugar mill (VSSSKL) is registered as a Co-Operative Society vide Registration No. SUR/MADH/PRG/(A), S90/1999 dated 21/05/1999. It is one of the progressive sugar mill in the Solapur district and has achieved excellent results since its establishment. The sugar mill has achieved best technical performance and expanded its capacity in short time span under the able guidance of Founder Chairman Hon. Shri. Babanrao Vitthalrao Shinde (MLA).

The initial installed crushing capacity of the sugar mill was 2500 TCD & the first crushing season was conducted in the year 2001-02. Based on increasing availability of sugarcane in area of operation, the sugar mill has expanded its crushing capacity from 2,500 TCD to 3,500 TCD in 2007-08, from 3,500 TCD to 6,000 TCD in 2011-12 and from 6,000 TCD to 12,500 TCD in 2013-14. VSSSKL has also installed a 49 MW co-generation plant.

The present capacity of the sugar mill is 12,500 TCD. During the season 2015-2016, the factory operated for 137 days and crushed 16.07 Lac MT of sugarcane with an average daily crushing of 11,767 MT of sugarcane (including stoppages). Since, the season 2015-2016 was the drought year, the sugarcane availability to sugar mill was less and accordingly, the average cane crush was low. However, during the month of December, 2015, the factory has crushed 3,92,076 MT of sugarcane in 31 days, resulting in a daily cane crush rate of 12,648 MT (including stoppages).

The last five years performance of sugar mill and future five years expected technical performance of the sugar mill is given in table 1.1 & 1.2.

Table 1.1: Last five years performance of sugar mill

Sr. No.	Particulars	Season				
		2012-13	2013-14	2014-15	2015-16	2016-17
1	Cane crushed (Lac MT)	11.88	10.79	17.56	16.07	10.00
2	Sugar production (Lac Qtls.)	13.55	11.92	19.50	17.29	11.50
3	Recovery % cane	11.41	10.90	11.03	10.76	11.50
4	Molasses production (MT)	47,348	41,815	70,122	66,983	42,000
5	Press-mud production (MT)	39,060	33,311	51,682	37,796	34,000

In the season 2016-2017 there was shortage of sugarcane because of draught conditions. Therefore, sugar mill was be able to crush about only 10.0 Lac MT of sugarcane. However, from the season 2017-2018 onwards, Sugar mill will be able to crush about 22.50 Lac of MT of sugarcane by crushing @ 12,500 TCD for 180 days. The average season days of the sugar mill for the last 10 seasons (from 2006-2007 to 2015-2016) has been 189 days. Accordingly, the season duration has been assumed to 180 days. The expected performance of the sugar mill in the coming five years is indicated in Table 1.2.

Table 1.2: Future five years expected performance of sugar mill

Sr. No.	Particulars	Season				
		2017-18	2018-19	2019-20	2020-21	2021-22
1	Cane to be crushed (Lac MT)	22.50	22.50	22.50	22.50	22.50
2	Sugar to be produced (Lac Qtls.)	25.875	25.875	25.875	25.875	25.875
3	Recovery % cane	11.50	11.50	11.50	11.50	11.50
4	Molasses to be produced (MT)	94,500	94,500	94,500	94,500	94,500
5	Press-mud to be produced (MT)	78,750	78,750	78,750	78,750	78,750

VSSSKL has installed 60 KLPD (Two units each of 30 KLPD) distillery plant based on molasses with Cascade Continuous /fed-batch fermentation with Multipressure distillation to produce R.S. or ENA or Anhydrous ethanol in the year 2003-04 & 2013-14. Both plants were supplied by M/s. Praj Industries Ltd., Pune. For effluent treatment they have installed biomethanation as primary effluent treatment system followed by

standalone multiple effect biomethanated spentwash evaporation as secondary effluent treatment system followed by biocomposting as tertiary effluent treatment system to achieve “Zero Spentwash Discharge” as per CPCB norms.

The performance of the both distillery plants is excellent. Both distillery plants are now running smoothly. The average rectified spirit production of existing 60 KLPD distillery plant for last three years is about 80 KLPD.

Last five years performance of the distillery plants and expected performance in the future five years is given in the Table 1.3 & Table 1.4 respectively.

Table 1.3: Last five years performance of distillery plant

Sr. No.	Particulars	Years				
		2011-12	2012-13	2013-14	2014-15	2015-16
1	Total Alcohol Production (Lac Lits./annum)	104.35	80.18	146.46	164.82	267.80
2	Total molasses Consumption (MT)	37,945	29,156	57,481	60,834	1,00,090
	Own molasses (MT)	55,689	47,348	41,815	70,122	66,983
	Purchased molasses (MT)	----	----	----	-----	33,107
3	Recovery of Rectified spirit (Lits./MT)	275.00	275.00	254.79	270.93	267.52
4	Fermentation Efficiency (%)	88.80	89.00	89.00	89.00	89.00
5	Distillation Efficiency (%)	98.32	98.45	98.23	98.32	98.40
6	Average working days / Annum	303	223	195	203	281
7	Average alcohol production (Lits./ day)	34,400	35,900	75,100	81,100	95,300

It can be seen from table 1.3 that the average production of alcohol from the year 2013-14 to 2015-16 was above 80 KLPD and recovery of Rectified spirit was about 270 liters/MT of molasses.

Table 1.4: Future five years expected performance distillery plant,

Sr. No.	Particulars	Years				
		2017-18	2018-19	2019-20	2020-21	2021-22
1	Average working days / Annum	270	270	270	270	270
2	Total alcohol (R.S. + I.S.) to be produced	216.00	216.00	216.00	216.00	216.00

	(Lac Lits./annum)					
4	Total molasses to be consumed (MT)	80,000	80,000	80,000	80,000	80,000
5	Expected recovery of Rectified spirit (Lits./MT)	270.0	270.0	270.0	270.0	270.0
6	Expected Fermentation Efficiency (%)	90.00	90.00	90.00	90.00	90.00
7	Expected Distillation Efficiency (%)	98.50	98.50	98.50	98.50	98.50

Socio Economic Activities: Apart from running the factory successfully and distributing the profit to member farmers, the management of VSSSKL is also involved in several Socio-Economic developmental activities for member farmers and workers. Some of the activities are briefly mentioned below,

- i) The sugar mill is giving medical aid to the employees and their dependents.
- ii) The sugar mill helps member farmers by supplying fertilizers, cane seeds and also arranges field demonstration & seminar to educate the farmers.
- iii) Sugar mill provides financial support to implement lift irrigation schemes and drip irrigation schemes in its area of operation.
- iv) Sugar mill provides the residential facility for the staff members.
- v) The labour welfare activities for workers are conducted at site.
- vi) Sugar mill has arranged mass marriage program every year at factory site.
- vii) The labour welfare activities for workers are conducted at site.

In short, the performance of existing 60 KLPD distillery plant of Vitthalrao Shinde Sahakari Sakhar Karkhana Ltd., is very impressive. To exploit more benefit from this industrial complex, the management of the sugar mill has decided to install 45 KLPD grain based distillery plant, boiler & TG set, stillage evaporation plant, dryer and Effluent treatment plant etc.

CHAPTER – II: PROJECT CONCEPT AND JUSTIFICATION

India is the largest producer of sugarcane as well as sugar in the world. The sugar industry occupies a pride of place in rural economy. Most of the sugar industries are located in rural areas providing employment to rural masses.

Justification for diversification to additional grain based distillery plant:

Due to increasing demand for alcohol in the country in the last few years and also due to shortage of molasses, the prices of alcohol are increasing day by day. Potable grade Rectified spirit (produced from molasses) price went up to almost Rs. 35.0 to 36.0 per liter. In the last two-three years the availability of alcohol has become very difficult. The present basic price of molasses and extra neutral alcohol (produced from molasses) is Rs. 5,000 to 5,500/MT and Rs. 40.00 to 42.00 /liter respectively. These prices are expected to remain high in the coming years due to increasing demand for alcohol. It has become difficult for liquor manufacturing units to purchase good quality alcohol from the open market and run economically. Therefore, many potable alcohol and liquor-manufacturing units are looking for alternate raw materials. One of the well established routes to manufacture potable alcohol and liquors is to use grains as feedstock. Grain alcohol and liquors made from grain alcohol have special value and can fetch higher price in the market. Also it will be worthwhile to note that there are abnormal variations in the price & availability of rectified spirit & molasses depending upon the availability of basic raw material, i.e. sugar cane. There is also no assurance of good return for molasses based rectified spirit. To fulfill this demand the management of has decided to establish a new distillery unit based on grains as the feedstock to produce superior quality of potable alcohol (Rectified spirit and Extra Neutral Alcohol).

Table 2.1: State wise grain based distilleries in India

Sr. No.	State	Category Based on Capacity			Total Number of Distilleries
		0-50 KLPD (Small)	50-100 KLPD (Medium)	100 KLPD and above (Large)	
1	Andhra Pradesh	02	09	04	15
2	Chhattisgarh	01	04	--	05

3	Assam	01	01	--	02
4	Haryana	04	05	03	12
5	Himachal Pradesh	02	--	--	02
6	Karnataka	02	03	--	05
7	Madhya Pradesh	01	06	01	08
8	Maharashtra	22	06	02	30
9	Punjab	04	05	07	16
10	Rajasthan	06	01	01	08
11	Uttar Pradesh	01	01	--	02
12	West Bengal	--	01	--	01
13	Jharkhand	--	01	--	01
14	Sikkim	--	01	--	01
15	Orissa	01	--	--	01
16	Bihar	01	--	--	01
	Total	48	44	18	110
Total installed capacity based on 300 working days, Million Lits/Annum=					2062.20

Establishing proposed grain based distillery project will be benefit to the farming community and surrounding environment due to following aspects:

- Maize /Rice crop is grown in normal soil.
- It grows in four months on rainwater
- Corn & rice are the crops that can be grown by small & marginal farmers because it does not need the infrastructure as in case of sugarcane.
- Corn /rice based distillery effluent can be treated more efficiently to produce DWGS or DDGS, which can be used as animal feed.
- The corn/ rice -based distillery will be zero pollution distilleries.
- Blackened or damaged rice can also be procured from market to produce alcohol.
- It is expected that the farmers in the surrounding area will grow corn in addition to conventional crops and supply it to the Vitthalrao Shinde S.S.K. Ltd.,

Rice, maize and other grains are one of the main course cereal crops of India. India's market year 2015-16 rice ending stocks are estimated to be 18.50 million tonnes (16.2 million government rice and 2.3 million tonnes private) due to higher procurement and relatively weak off take, according to the FAS. Market year 2016-17 ending stocks

are also forecasted to be higher at 16.4 million tonnes on normal procurement and government off take.

Maize is the third most important cereal crop in India after rice and wheat. It accounts for 9% of total food grain production in the country. Karnataka, Rajasthan, Andhra Pradesh, Maharashtra and Uttar Pradesh are the major maize producing states; together contribute 60% of area and 70% of maize production in India. In India in 2015-16, maize occupied 86.27 lakh ha area and production was estimated 13 percent low to about 210.20 lakh tonnes (Third Advance Estimates dt. 9-5-2016) as against 92.71 lakh ha and 241.7 lakh tonnes in previous year, respectively.

The production of major crops during 2015-16 in India is as follows:

Food grains:-

- Rice – 103.61 million tonnes
- Wheat – 93.82 million tonnes
- Coarse Cereals – 38.40 million tonnes
- Maize – 21.00 million tonnes
- Pulses – 17.33 million tonnes
- Tur – 2.55 million tonnes
- Gram – 8.09 million tonnes

India is second largest producer of corn/rice in the world. This crop is ideally suited for semi-arid agro climatic regions of the country and it gives reasonably good yield with minimal requirement of irrigation and fertilizers. Since corn/rice must be cultivated in semi-arid regions as fodder to feed the large cattle population of the country, industrial applications for this grain are being explored so that corn/rice cultivation becomes economically viable for small & marginal farmers. While the area under corn/rice cultivation in India is consistently declining, the yield is increasing year by year and thus the overall production of corn/rice is increasing.

Corn/rice is grown in the Kharif (Rainy season) and Rabi (Post rainy season) but the share of Kharif is higher both in terms of area under cultivation & production. The Kharif corn/rice crop accounts for 55% of the total area under cultivation and 68% of the total production. Also the yield of Kharif season is much higher than Rabi. Produce of Kharif season gets damaged to the extent of 20% and fetches a low price of Rs. 2500-

4,500 /M.T. as compared to Rs. 4,000-6,000 /M.T. for Rabi crop. One of the reasons for low farm gate price for Kharif corn/rice is that there are several layers of traders between farmer and consumer whereas Rabi crop has good demand and does not go through so many layers of traders. Rabi crop is almost entirely used for human consumption whereas Kharif crop is not very popular for human consumption and is largely used for animal feed, starch and alcohol industry.

The consumption pattern of rice grains indicates that the demand for rice as food would decrease, however the demand for Industrial use is set to increase due to availability of sound technical knowledge & encouragement by Government. The major industry sector consumers are Poultry sector (also replacing share of maize), Dairy sector, Alcohol sector & Starch sector. Amongst these sectors alcohol industry is having the largest share.

The major application of maize is animal feed, production of starch/starch derivatives and ethanol production. Corn/rice grains fetches lower price when used for animal feed and the quantity used for starch industry is very small. Therefore, use of rice for production of Potable Alcohol would help the poor farmers because they will get a good price for their produce.

Out of total stock 18.50 million MTs of corn/rice, about 2-3 million MT is wasted due to grain blackening following un-seasonal rains. This grain is not suitable for human or animal consumption. Hence, it is sold at a low price and thus gives lower returns to the farmers. Thousands of the marginal farmers will be benefited if such grains can be used for Potable alcohol production.

Rice has higher starch contents when compared with maize. Rice is the best suited amongst all coarse grains for the production of alcohol because of higher yield as compared with the industry average. The process for alcohol production using Corn or rice is preferable as it is environment friendly compared to molasses. Use of Corn or rice for alcohol/ethanol production will use up to 10-15% of the mold damaged grain, which will help farmers to get a good price for their produce.

The proposed project mainly consists of following major sections:

1. Grain processing section
2. Distillery unit

3. Decantation
4. Stillage evaporation plant
5. Dryer
6. Secondary effluent treatment plant
7. Boiler
8. TG set etc.

While the current financial viability analysis is based upon selling the entire products in India, the export market potential is also tremendous. The promoters may consider entering export market at a later stage either on their own or with a suitable tie-up with international partner for marketing.

Comparative advantages of grain-based distillery over molasses based distillery are given in the following table 2.2.

Table 2.2: Comparison between Molasses and Grain based distilleries to produce alcohol

	Molasses based Distillery to produce alcohol	Grain based Distillery to produce alcohol
Pollution Aspect	<ul style="list-style-type: none"> • Molasses based distilleries are highly polluting and are categorized as “Red” in our country. • The norms for treatment of molasses based distillery are becoming stringent and therefore, the treatment cost is increasing day by day. 	<ul style="list-style-type: none"> • It is a “Green Field” project with zero discharge. • Residual matter can be used as fuel in the boiler or can be converted to high protein containing animal feed.
Installed capacity	<ul style="list-style-type: none"> • About 4500 million litres. Considering maximum availability of 10.50 – 11.50 million MT of molasses in the country, maximum alcohol that can be produced is about 2500 million litres (More than 350 units.) 	<ul style="list-style-type: none"> • Surplus raw material (Corn, Rice Wheat, Millet etc.) is available. • In the last few years, about 1000 million liters/annum of grain alcohol have been produced and this trend is increasing every year.
Quality of alcohol	<ul style="list-style-type: none"> • Inferior in quality. Though used in India to produce Liquors, it is not suitable to produce good quality liquors. It contains sulphur containing compounds and other impurities, which even at ppm level can 	<ul style="list-style-type: none"> • Used worldwide to produce various grades of liquors of superior quality.

	<p>affect the quality of alcohol.</p> <ul style="list-style-type: none"> • It is suitable for industrial purpose. 	
Yield	<ul style="list-style-type: none"> • 250-270 liters of alcohol per MT of molasses. 	<ul style="list-style-type: none"> • 400-418 liters of alcohol per MT of Corn, Sorghum or Rice.
Crop specific limitations	<ul style="list-style-type: none"> • Sugarcane is long duration crop and requires high level of irrigation. There will be always limitations on how much sugarcane can be grown in our country 	<ul style="list-style-type: none"> • Cereal grains are short duration crops with substantially less irrigation water requirement. Many parts of the country can produce more cereal grains if there is a good demand for them.
Seasonal nature	<ul style="list-style-type: none"> • Many molasses based distilleries are attached to Sugar mills and therefore, these distilleries also run only during the sugarcane crushing season. • However, some molasses based distilleries now run for almost 270 days in a year. 	<ul style="list-style-type: none"> • Grain based Distilleries, because of non-polluting nature, can run for 300 to 350 days in a year. • Low grade or damaged food grains, which are available sometime at throwaway price, can also be used for grain alcohol production.
Technological Developments	<ul style="list-style-type: none"> • Molasses is very complex substrate. The quality of molasses is deteriorating day by day due to the tendency of sugar factories to extract maximum sugar. 	<ul style="list-style-type: none"> • Very promising new developments (such as raw starch hydrolysis, new generation of efficient enzymes, dry degermination etc.) are taking place in dry milling grain alcohol production, which will bring down the cost of conversion substantially in future.
Future trends	<ul style="list-style-type: none"> • Due to increasing cost of petroleum crude, parallel alcohol based route to produce vital industrial chemicals is becoming more viable. Therefore, in future molasses alcohol will mostly go for industrial use. Part of the molasses alcohol will also be converted to “Fuel ethanol” for blending with petrol. This 	<ul style="list-style-type: none"> • Slowly, we are expecting a switch-over in our country so that grain alcohol will be mostly used for liquor manufacturing. Some grain alcohol may also be converted to “Fuel ethanol” provided the raw material is

	<p>demand is expected to increase day by day for which there is no sufficient molasses in the country. Central Government is also formulating National Ethanol Policy, which is expected to promote Fuel ethanol production from molasses. Thus, most of the molasses will be utilized for industrial and fuel ethanol production and therefore, there will be shortage of molasses alcohol for potable purpose.</p>	<p>made available at competitive price. This is one of the recommendations of draft of model excise policy prepared by ministry of Food Processing, GOI.</p>
Export Potential	<ul style="list-style-type: none"> • No or very limited export potential. • Molasses alcoholic fermentation CO₂ is not suitable for food purpose/ grade. 	<ul style="list-style-type: none"> • Being superior in quality for manufacture of alcoholic beverages, there is a good export potential. Similarly, DDGS also can be exported in future. • Grain based CO₂ is food grade. Therefore in future there is a scope to put-up a food grade / beverages grade CO₂ plant. • It is also possible to go for liquor project (Country liquor or IMFL) in future, which will further improve the economic viability of the project.
Cost of conversion	<ul style="list-style-type: none"> • Lower cost of conversion as no pretreatment is required. • However, the cost of effluent treatment per liter of alcohol is increasing day by day and it is becoming very difficult to meet the ZLD norms laid down by the pollution control authorities. 	<ul style="list-style-type: none"> • As starch of grain has to be first hydrolyzed to fermentable sugars, pretreatment such as milling, pre-liquefaction, jet cooking, post-liquefaction etc. is needed. This on an average increases the cost of conversion by about Rs. 2.0 to Rs. 3.0 per liter of alcohol produced

Capacity of distilleries:

Normally distilleries are expected to work for 300 days in a year. Hardly any distillery works for 270 days in India, due to several problems faced by the industry. The working days per annum drop to as low as 200 days and even lower than this.

Some distilleries in India have adopted seasonal working of their distilleries in view of the fact that they can supply surplus steam from their sugar mills. It is an important consideration to keep the cost of production low. If distillery faces frequent closures due to various reasons during the season the capacity utilization falls down to as low as 40 % to 50 %. Some sugar mills are now thinking to run their distilleries beyond the sugarcane-crushing period by installing independent boiler and TG set.

Following few suggestions shall be useful for proper designing of the distillery.

In order to maximize alcohol production and capacity utilization, sufficient quantity of raw material should be made available.

1. Distillery should have adequate storage capacity for storage of raw material.
2. The distillery should have a separate boiler of adequate capacity & turbo-generator set for assured supply of steam & electricity in order to ensure non-interrupted process operation and better capacity utilization.
3. Management should take efforts to run the distillery for minimum 300 days.
4. Distilleries should adopt suitable effluent treatment plant and achieve zero pollution.
5. The capacity of the grain based distillery should be min. 30.0 KLPD

Location considerations:

The important factors for installation of new distillery unit are,
a) Nearness to raw material (b) Availability of utilities such as steam, electricity and water (c) Adequate land for distillery and effluent treatment plant (d) Avoiding likely odour nuisance to the residential colony and the public in general (e) Availability of technical assistance in case of necessity (f) Ease of control over both sugar mill as well as distillery by one management and sharing common facilities like workshop etc.

The sugar mill has ample vacant land adjacent the existing distillery plant. The proposed 45 KLPD distillery plant, boiler & TG set will be accommodate in the vacant land.

Raw material availability and storage:-

For the proposed 45 KLPD grain based distillery, it will be necessary to have scientifically designed storage facility. During the period when grain prices are running low it is advisable to purchase sufficient quantity and store it for use in other seasons. Usually, 5.0 to 10.0 % losses take place during storage of grains and therefore, necessary care should be taken to prevent losses during storage. 30 days storage silos (2 numbers) to store grains are considered in the cost of the project. If it is required, additional storage capacity (godowns) can be taken on rental basis in nearby area. These godowns will be properly modified to minimize losses during storage.

World's grains production countries is given in the table 2.4. Similarly, world's top ten countries for corn, rice, wheat, sorghum and sugarcane production is given in the table 2.5.

Corn from other neighboring states and other grains (such as rice) also can be made available for the proposed grain based distillery unit. Thus, the requirement of 33,000 MT of grains/annum (such as corn, rice etc. containing min. 62% starch) for the proposed distillery can be easily made available. The following table nos. 2.3 & 2.4 shows world's top most grain production countries.

Table 2.3: World's grains production countries

Cereals	First	Second	Third	Fourth	Fifth
Barley	Russia	Germany	France	Canada	Turkey
Buckwheat	Russia	China	Ukraine	France	Poland
Maize (corn)	United States	China	Brazil	Argentina	Ukraine
Millet	India	Niger	China	Mali	Burkina Faso
Oat	Russia	Canada	Finland	Poland	Australia
Rice, paddy	China	India	Indonesia	Bangladesh	Vietnam
Rye	Germany	Russia	Poland	Belarus	Ukraine
Sorghum	United States	Mexico	Nigeria	India	Ethiopia
Triticale	Poland	Germany	France	Belgium	Russia
Wheat	China	India	United States	Russia	France

Table 2.4: World's top 10 countries for production of corn, rice, wheat & sugarcane:

1) Corn production:-

Rank	Country	Production in 1000 MT
1	United states	3,84,778
2	China	2,19,554
3	Brazil	86,500
4	European Union	60,309
5	Argentina	36,500
6	Ukraine	28,000
7	Mexico	26,000
8	India	24,500
9	Russia	15,500
10	Canada	13,200

Source: <https://apps.fas.usda.gov>

2) Rice production:-

Rank	Country	Production in 1000 MT
1	China	1,44,560
2	India	1,04,800
3	Indonesia	35,560
4	Bangladesh	34,500
5	Vietnam	28,234
6	Thailand	18,750
7	Burma	12,600
8	Philippines	11,915
9	Brazil	8,465
10	Japan	7,842

Source: <https://apps.fas.usda.gov>

3) Wheat production:-

Rank	Country	Production in 1000 MT
1	European Union	1,60,012
2	China	1,30,190
3	India	86,530
4	Russia	61,044
5	United states	56,117
6	Canada	27,594
7	Ukraine	27,274
8	Pakistan	25,100
9	Australia	24,500
10	Turkey	19,500

Source: <https://apps.fas.usda.gov>

4) Sorghum production:-

Rank	Country	Production in 1000 MT
1	United States	11,740
2	Mexico	6,500
3	Nigeria	6,500
4	Sudan	5,500
5	India	5,500
6	Ethiopia	3,700
7	Argentina	3,400
8	China	3,200
9	Australia	2,200
10	Burkina Faso	1,900

Source: United States Dept. of Agriculture

5) Sugarcane production:-

Rank	Country	Production in Lac MT	Total % of world
1	Brazil	7680.90	40.40
2	India	3412.00	17.90

3	China	1282.00	6.70
4	Thailand	1000.95	5.20
5	Pakistan	637.50	3.30

Sources: FAOSTAT data, 2016 (last accessed by Top 5 of Anything: June, 2016).

Water requirement:

The sugar mill management has planned to install new 45 KLPD grain based distillery plant for production of rectified spirit or ENA.

Total fresh requirement of water for existing 45 KLPD grain based distillery plant will be around 850M³/day.

Ground water storage tank of 15,000 M³ is available with the sugar mill and water required for the distillery will be drawn from the sugar mill water reservoir. Sugar mill is receiving water from Ujani Dam back water. Thus, sufficient quantity of water can be made available to achieve better efficiency and to maintain the plant and machinery in good condition. It is necessary to have proper water treatment system. Suitable water treatment plant for supply of filtered water for process, soft water for cooling tower make-up and DM water for dilution of spirit has been considered in the plant and machinery.

Steam requirement & power generation:

Steam:-

The steam requirement will be 7.00 - 7.50 MT/hr for the 45 KLPD grain based distillery & 3.75 - 4.00 MT/hr for standalone stillage evaporation plant. However, this steam requirement is tentative and may vary slightly depending on technology selected for evaporation. At present the sugar mill has installed five boilers with steam generation capacity of 310 MT/hr. However, excess steam from these boilers for distillery and stillage evaporation plant cannot be made available. Therefore, VSSSKL has proposed to install an independent 18 MT/hr steam producing capacity boiler having 45 kg/cm² (g) pressure for distillery and stillage evaporation plant. Therefore, required steam will be made available for distillery and stillage evaporation plant from the proposed boiler.



Power: -

Existing power generation capacity of VSSSKL is 49 MW during crushing season. VSSSKL is going to install 18 MT/hr capacity new boiler and 1.50 MW capacity new turbine separately for distillery and ETP system. The estimated requirement of power for existing & proposed distillery as well as ETP will be 1400 KWH. The required electricity for 45KLPD distillery & ETP will be generated and supplied from the independent distillery boiler and TG set.

Power for idle days will be supplied through the DG set of the sugar mill or purchased from State Electricity Board at the rate of Rs. 5.20/unit and Rs. 9.20/unit respectively.

It will be also necessary to work out the exact steam and power balance during the tendering process for the 45 KLPD distillery unit & new multiple effect evaporation plant & new boiler with TG set.

The services of workers and the engineering staff of the sugar mill could be readily made available in case of necessity. The nearness of the distillery to sugar mill is also of advantageous from the point of security.

As per above reaction 162 gm of starch produces 180 gm of glucose. Therefore, 1 MT of starch gives 1111.11 gm of glucose.

180 gm. of glucose on reaction gives 92 gm. of alcohol. Therefore, 1 MT of sugar gives 511.1 kgs of alcohol. The specific gravity of alcohol is 0.7934, therefore, 511.1 kg. of alcohol is equivalent to $511.1/0.7934 = 644.19$ litres of Alcohol. During fermentation, other by-products like glycerin, succinic acids etc also are formed from sugars. Therefore, actually 94.5% total fermentable sugars are available for alcohol conversion. Thus, one MT of sugar will give only $644 \times 0.945 = 608.6$ litres of alcohol, under ideal conditions theoretically. Similarly, one MT of pure starch should give 715.0 liters of alcohol under ideal conditions, theoretically (at 100 % efficiency and 100 % ethanol). Corn or sorghum contains about 62.0 % starch on dry weight basis. Therefore, one MT of corn or sorghum can yield about 410 liters of Rectified Spirit.

For bringing out above biochemical reaction, we require proper and careful handling of yeast, control of optimum parameters like pH and temperature and substrate concentration and enzyme dose, which results into effective conversion of starch to sugars and then to alcohol.

For propagation, yeast is developed in the laboratory from the pure yeast culture slant. In first step yeast is propagated in a test tube. Then it is transferred to a 500ml conical flask and propagated for 12 hrs. This is further transferred to 5 litres flask containing the sterilized medium. The pH of the medium is adjusted in the range of 4.5 and nutrients such as ammonium sulphate or urea, di-ammonium phosphate etc. are added. Each stage of development of yeast from test tube to 500ml and 500ml to 5 litres requires 24 hours.

On the plant, there are again 3 stages of propagation namely 100 litres, 500 litres and 5000 litres of culture vessels. All these vessels are designed so as to facilitate boiling medium in order to sterilize it and also cool to bring it to the proper temperature of 32°C . Further stages of yeast propagation are done in tanks. i.e. Pre-fermenters, which requires about 8 hours in order to build up necessary concentration of yeast cell mass. Finally pre-fermenter is transferred in the fermenter. Simultaneously grain slurry is transferred to fermenter.

Now a day, readymade active dry yeast is used directly in the pre-fermenters. Good quality of active dry yeast is available for use in distillery. The yeast is manufactured under strict controlled conditions. This yeast is useful to obtain a good yield of alcohol by fermentation.

Grain based distillery plant process details

Raw material

Mostly Broken Rice, Maize, Millet and Sorghum or mixed grains are being used as raw material in the distillery units. Following table no. 4.1 & 4.2 are indicating the starch percentage & alcohol yield from various grains.

Table 4.1: Grain starch percentage and alcohol yields

Sr. No.	Grain	Fermentable carbohydrate (Starch %)	Alcohol yield (Lits. of alcohol/MT)
1	Rice	62-67	380-418
2	Sorghum	62-65	380-410
3	Wheat	62-65	380-410
4	Maize	62-65	380-410
5	Malt	58-59	389-395

Table 4.2: Composition of various grains

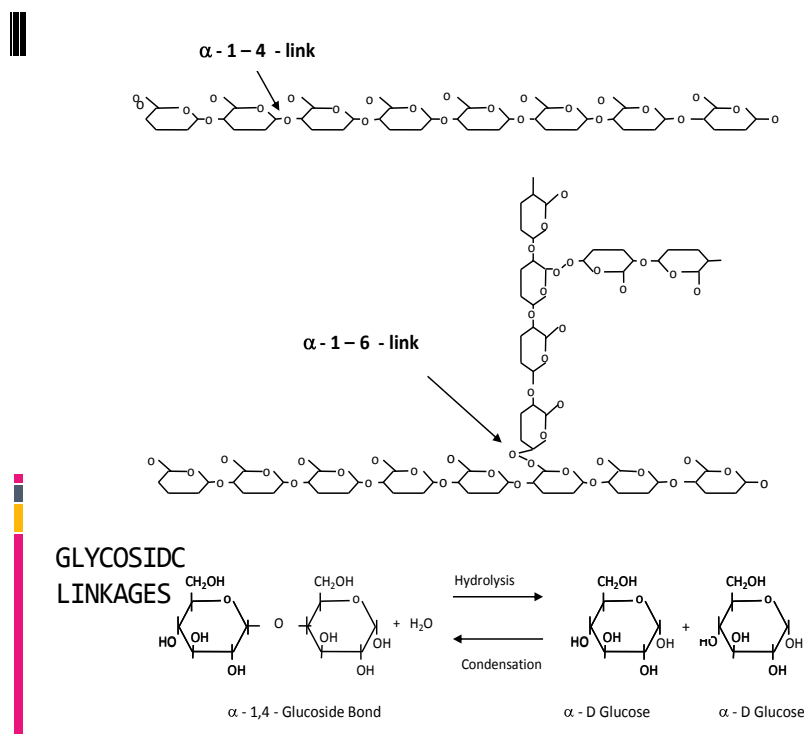
Grain	Moisture (% w/w)	Starch (% w/w)	Proteins (% w/w)	Fats (% w/w)	Crude Fiber (% w/w)	Ash (% w/w)	Other Solids (% w/w)
Rice	8-10	65-70	7-8	1-1.2	0.8-1	0.8-1	8.8-9
Wheat	8-12	59-63	11-13	1-2	2-3	1.5-2.5	7-10
Corn	8-12	60-64	9-12	3.5-6	1.5-2	1-2.5	7-10
Sorghum	9-10	65-70	7-8	3-3.5	2.3-2.5	1.5-1.6	1.5-1.7
Millet	8-10	65-70	10-11	4-4.2	0.8-1	3-3.3	1.8-2
Barley	7.5-8	60-63	7-9	2.5-3.5	9-10	1.5-2.5	6-8

- ❖ Starch hydrolysis: Starch can be hydrolyzed to fermentable sugar (Glucose) by enzymatic hydrolysis. Following two enzymes are commonly used for starch hydrolysis in grain based distillery.

- 1) Alpha Amylase/Exo-amylase -Amylose is a polymer of 500 -1500 glucose units joined by ∞ 1-4 linkage in linear form approximately 15 – 20 % of total starch.
- 2) Glucoamylase /Endoamylase/Amyloglycosidase -Amylo-pectin is branched polymer of glucose; joined by 1-4 ∞ linkage in linear form section and cross linkage by 1-6 ∞ linkage. A molecule of amylopectin consists typically 500 – 40,000 unit glucose units approximately 80-85% of total starch.

Enzyme	Optimum pH range	Optimum temperature
Alpha amylase	5.5-6.0	88-90
Glucos amylase	4.5-4.8	55-60

Figure 4.1: **Components of starch**



Process Description:-

The incoming grains (corn or sorghum or rice) are inspected upon receipt. Inspection is carried out to determine the starch content, bushel weight, moisture content, mold infestation and general appearance. The accepted quality corn grain is unloaded into silos for storage before milling. The stored grain is weighed to determine the incoming quantity.

Silos for grain storage:-



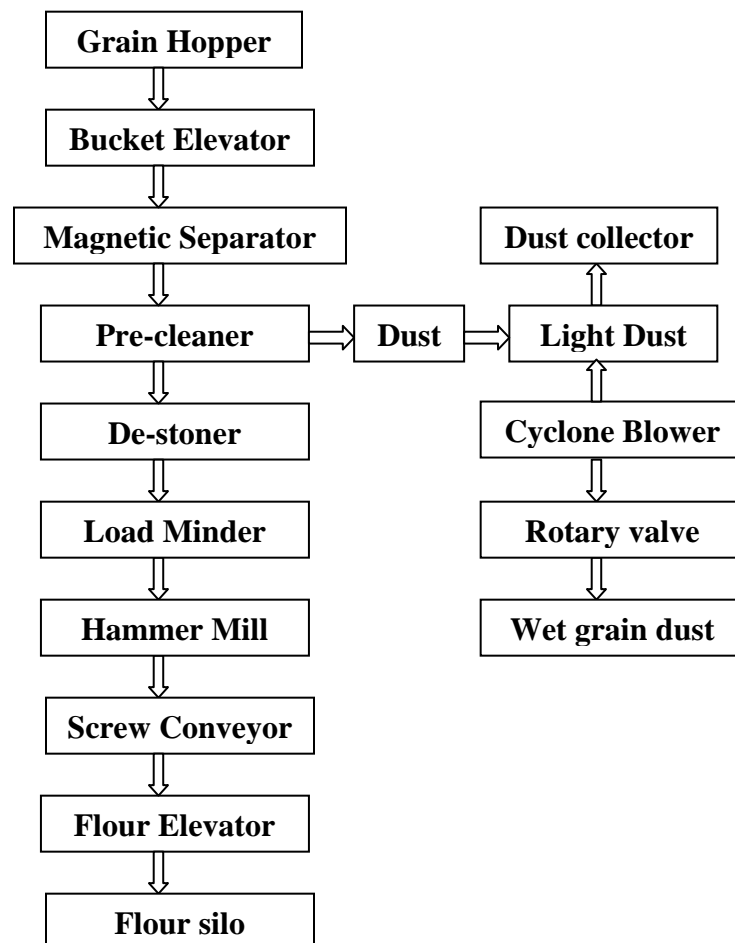
Grain Handling & Milling:-

System involved in Grain handling system:

1. **Grain Unloading:** Involves receiving hopper with magnetic grill and bucket elevator.
2. **Grain Storage:** Storage silos with feeding arrangement and sweep auger and chain conveyor for discharge.
3. **Grain cleaning:** Involves pre-cleaner (vibratory screen) separating oversize and undersize impurities, Destoner for removing stones and magnetic drum separator for removing iron particles.

4. **Grain Milling:** Involves rotary feeder for controlled feed, hammer mill to achieve desired particle size and capacity. Hammer mill discharge arrangement with screw conveyor, rotary screen for coarse separation.
5. **Flour handling:** Involves mechanical or pneumatic conveying, screw conveyor, bucket elevator, rotary valves with roots blowers.
6. **Flour Storage:** Flour storage silo is provided with bin activator for a smooth discharge. Silo is provided with level switches high and low and load cells for weighing/automation.
7. **Flour weighing and batching:** Weight controller and totalizer for automation and to know the flour consumption. Unique equipment called **Pre-masher** is used for metered feed of flour and water to get uniform slurry for liquefaction.

Figure 4.2: Flour weighing and batching

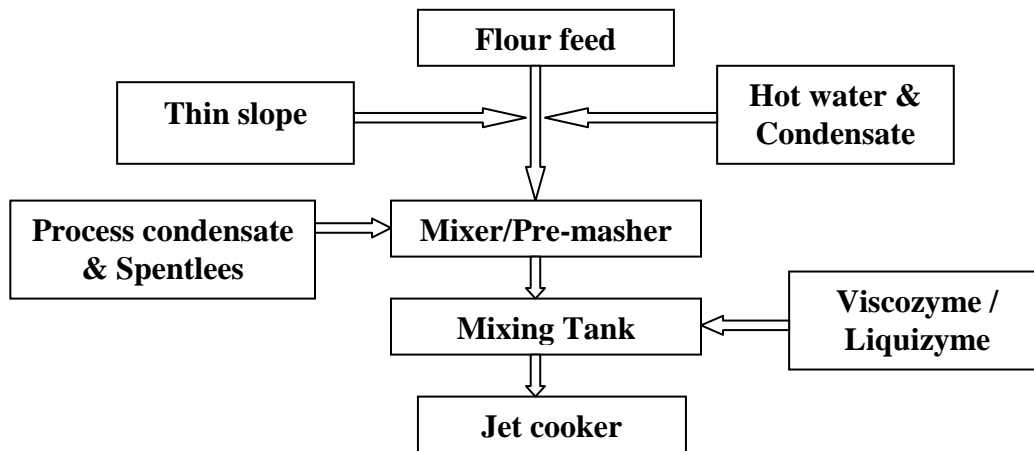


Grains are stored in the silos from there it is conveyed through screw conveyor to bucket elevator. Bucket elevator lifts the grains to approximately 18m height and then passes the grains through vibrating screen, de-stoner and magnetic separator to remove dust and stones, the flow through this equipment are under gravity.

The cleaned grains are then again conveyed by bucket elevator to an intermediate hopper, which are provided with rotary air lock system for controlled flow in hammer mill. In hammer mill the particle size is reduced (Size 400-700 μ) as per required for the process. The size distribution test or "sieve analysis" of the flour is done regularly in order to ascertain the mill setting and particle size distribution. From hammer mill the flour is pneumatically conveyed to flour bin (Intermediate storage for flour). From flour bin the flour is carried to pre-masher for slurry preparation.

In pre-masher, flour & required quantity of water are transferred by conveyer. Uniform grain slurry is made and transferred to another low shear tank (slurry tank) for proper mixing. In slurry tank required pH of 6.0-6.2 is maintained by using lime if required and temperature as 55⁰C to 60⁰C. An enzyme called α -amylase is added here in small (20-25%) dose before the cooking process starts.

Figure 4.3: **Slurry preparation:**



Cooking: The grain slurry is pumped from mixing tank (Slurry tank) to Jet Cooker (Hydro Heater) through open impeller centrifugal pump. In jet cooker steam is applied at 3.5 kg/cm² pressure to cook the starch slurry to break down the chemical structure of starch in presence of enzymes. The temperature of grain slurry at outlet of jet cooker is

maintained between 115 to 120⁰C, after cooking the grain slurry is passed through the retention vessel to provide desired retention time at a given flow rate to convert starch into dextrin. In this step slurry pressure & viscosity reduces. The slurry which is hot is transferred into the flash tank to reduce the temperature of the slurry to 90- 95⁰C before sending to final liquefaction tank. Flash tank is attached to flash condensers where vapours are condensed and condensate is sent to slurry tank.

Figure 4.4: **Cooking**

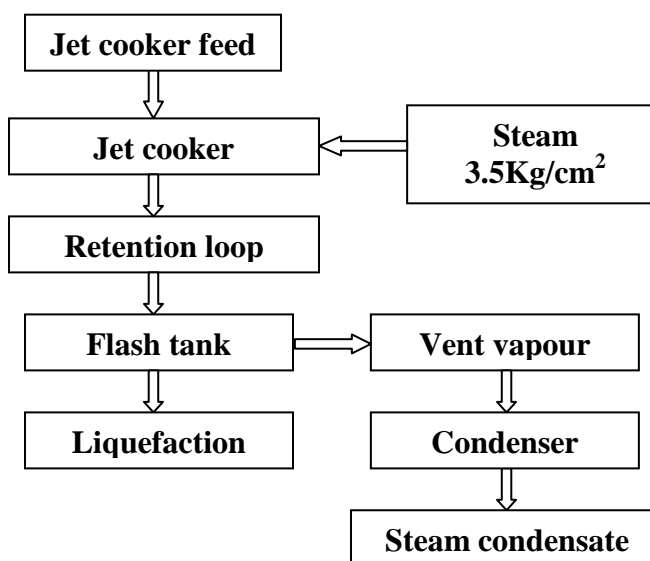


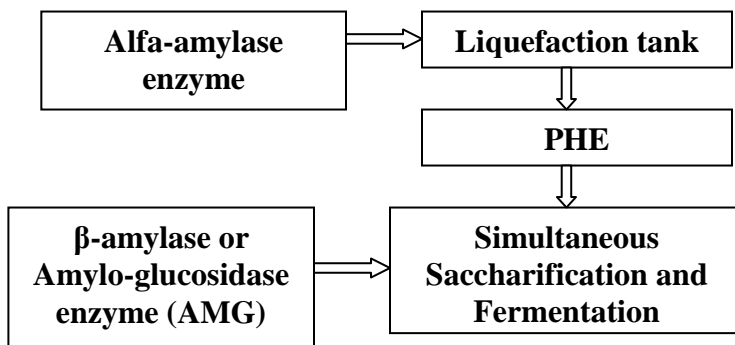
Table 4.3: Characteristics of starch in cereal grain

Cereal Grain	Gelatinization Temp. ⁰ C	Shape	Granule size (µm)
Barley	51-60	Elliptical Spherical	20-25 2-6
Wheat	58-64	Lenticular Round	25-35 2-10
Corn	62-72	Round/Polyhedral	15
Rice	68-78	Polygonal	3-8
Sorghum	68-78	Round	15
Oats	53-59	Polyhedral	3-10
Rye	57-78	Round/ Lenticular	28

Liquefaction: Grain slurry is transferred to final liquefaction tank from flash tank where remaining 75 to 80% of enzymes of α -amylase is added which convert starch to dextrin and 1-4 α -glycosidase linkages are hydrolyzed into amylose and amylo pectin. Enzymatic activities rapidly break-down the starch molecules to soluble dextrans and oligosaccharides. To have good conversion of starch to dextrin retention time should be about 1 hr.

Saccharification: From the liquefaction chamber, the mash is pumped through a heat exchanger to be cooled for simultaneous saccharification. Simultaneous saccharification is the formation of fermentable glucose and the process is carried out in fermenters with fermentation process. The breakdown of dextrin's formed during liquefaction takes place with the help of a second enzyme, Amylo-glucosidase. The pH is required to be adjusted in the range of 4.0 to 5.0 and the optimum temperature for the Amylo-glucosidase enzyme is about 30-35⁰C. The quantity of glucose produced is monitored by measuring the Dextrose Equivalent (DE) of the mash.

Figure 4.5: **Liquefaction and Saccharification:-**



Fermentation:

Fermenters are cylindrical & vertical with conical top & flat sloping bottom. Fermenters are equipped with side entry agitators.

Final liquefied slurry from final liquefaction tank is pumped into fermenter and is diluted to appropriate sugar concentration with process water. During fermentation process, saccharification progresses further and releases glucose required by yeast.

Fermentation is initiated by inoculating with required quantity of yeast. The assimilable nitrogen is added in the medium in the form of urea and di-ammonium phosphate.

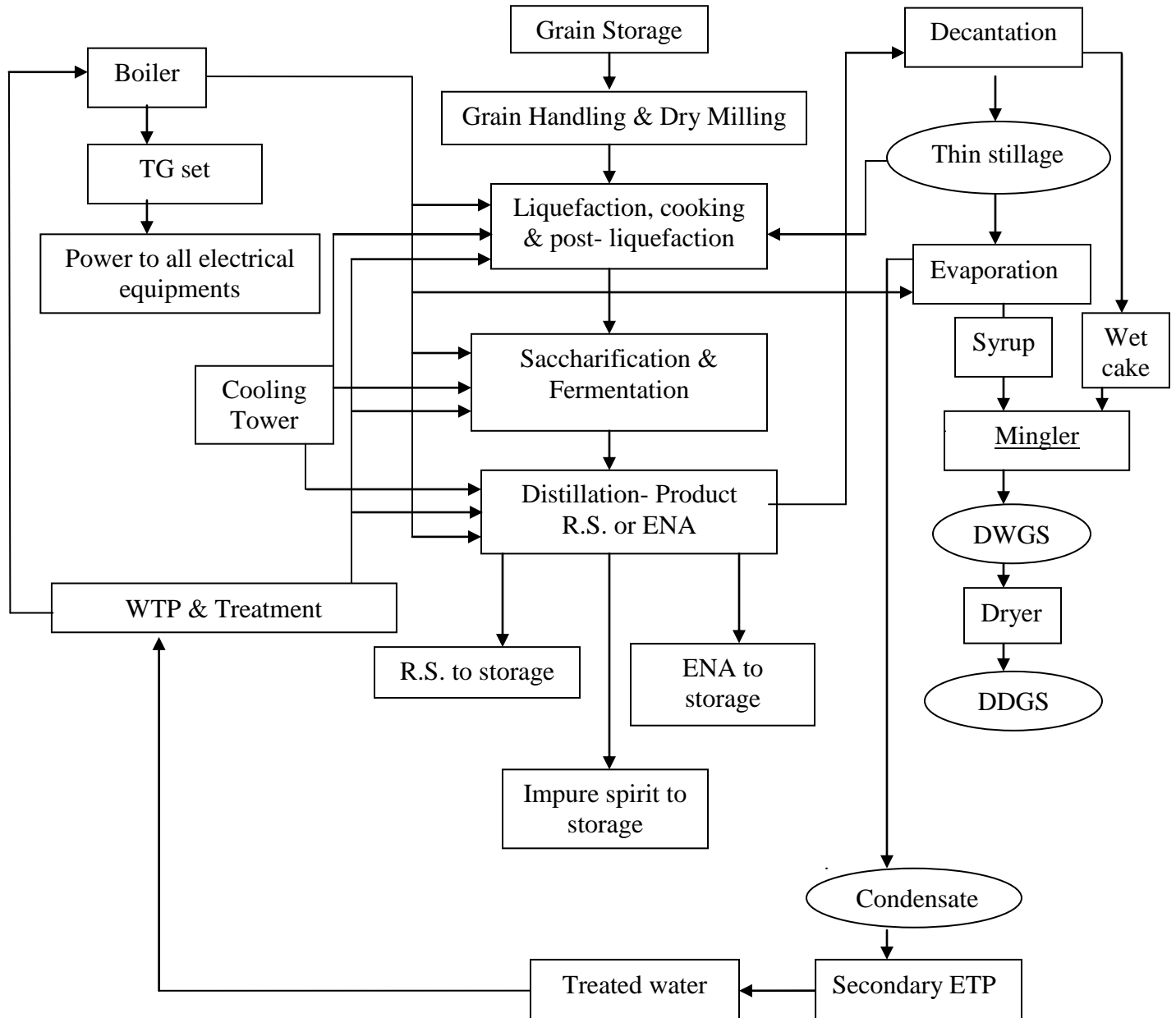
Temperature in the fermenter is maintained at 32°C with the help of external wide gap plate heat exchanger (PHE). The fermented mash is re-circulated continuously through the PHE. Recirculation also helps in proper mixing of fermented mash. The rate of fermentation reaction gradually increases and after about 55 to 65 hours fermentation completes. At the end of fermentation, the alcohol concentration in the mash is 10.0 to 12.0 % (v/v). This section will have six fermenters of capacity given 70 hours retention time. After completion of fermentation the mash is transferred to mash holding tank.

The CO₂ which is liberated during fermentation is scrubbed in water, in CO₂ scrubber. This CO₂ contains alcohol, which is recovered by collecting CO₂ scrubber water into mash holding tank. If required, CO₂ can be collected, washed, purified and compressed in cylinders to be sold in consumption for beverages production. However, in the present report this aspect is not considered.

Table 4.4: Pre-fermentation & Fermentation parameters

Tank	Initial pH	Final pH	Temp °C	Set up R.S.	Setup Sp. Gr.	Final Specific Gravity	Final Alcohol
Per- Fermenter	4.5	4.0	32-33	4.5%	1.045	1.025	1-1.5%
Fermenter	4.5	3.8	32-33	12%	1.050	1.000	10-12%

Figure 4.6: GRAIN TO ETHANOL PROCESS FLOW DIAGRAM



CHAPTER-V: MULTIPRESSURE DISTILLATION TECHNOLOGY

After fermentation the next stage in the manufacture of alcohol is to separate alcohol from fermented wash and to concentrate it to 95% (v/v) alcohol called as Rectified spirit. For this purpose, method of distillation is employed.

It's a physical process various compounds of a mixture get separated by virtue of their differences in boiling points.

The distillation columns consist of number of bubble cap /Rh grid plates where wash is boiled and alcoholic vapours are separated and concentrated on each plate stage by stage.

MULTIPRESSURE DISTILLATION:

Vacuum distillation is defined as that in which the operating pressure in the system is either less than atmospheric pressure or more than atmospheric pressure. Vacuum is nothing but sub-atmospheric pressure (negative gauge pressure).

Fermented wash to rectified spirit & ENA: Multi-pressure distillation system for production of Rectified spirit & ENA consists of distillation columns namely-

For –Rectified Spirit mode

1. Degasifying cum analyzer column
2. Rectification column
3. Fusel Oil Concentration column
4. Extractive Distillation column

For –ENA mode

1. Degasifying cum analyzer column
2. Pre-rectifier column
3. Extractive Distillation column
4. Rectification column
5. Refining /Simmering column
6. Fusel Oil Concentration column
7. Head Concentration column

Advantages of MPR Distillation:

- 1) Maximum Heat Integration is possible.
- 2) Few columns operate under vacuum, few under pressure and few under atmospheric pressure.
- 3) Resolution of impurities is better.
- 4) Analyzer column operates under vacuum. Therefore Scaling is minimized in distillation.
- 5) Formation of by-products such as acetal is minimized - improvement in quality of alcohol.
- 6) Pre-rectification column ensure removal of sulfur compounds /mercaptans, reduces load of lower boiling volatile compounds
- 7) Low steam consumption with reboiler (2.2 Kg/lit. of Rectified Spirit)
- 8) Stillage generation is less.

The distillation system is designed for the production of potable alcohol. The distillation system comprises seven columns namely Analyzer/Degasifying column, Pre-rectifier column, Extraction column, Second Rectifier column & Refining column. The Fusel Oil column, Head Concentration column are used for concentrating & removal of Fusel Oil & impurities. After separation of impurities the recovered alcohol is recycled back to the pre rectifier column system.

Process –

The fermentation mash containing alcohol, non-fermentable solids and water is supplied to Distillation to separate the alcohol and other impurities, as a continuous flow.

The Distillation system is designed for premium quality Extra Neutral Alcohol. The system details are as below:

The system consists of 7 main columns, namely, Degassifier, Stripper column, Pre-rectifier column, Extraction column, Rectification column, Refining column, Fusel Oil column.

Wash is fed to Degassifier/ Stripper column. Top vapours of Degassifier are fed to Condensers. Alcohol is stripped off water in stripper column. The top vapours from stripper column are fed to pre-rectifier column as feed and as heat source too. The



exhaust column receives bottom from Pre-rectifier column, which produce alcohol rich vapours at top & fed back at bottom of Pre-rectifier column. The spent lees is taken at the bottom of exhaust column & fed to ETP after heat recovery. Exhaust column require small amount of steam, which can be directly injected in to the column. Pre-rectifier removes most of the fusel oils. Top of the Pre-rectifier column are condensed in condenser and draw of the distillate from pre-rectifier column is fed to extraction column. The alcohol is diluted with Soft/DM water used as dilution water in extraction column. In extraction column most of the high boiling and low boilers impurities along with esters are separated from ethanol by volatility inversion in presence of water. The bottom ethanol water mixture is pre-heated and fed to rectifier column. Top vapours of Rectifier column are fed to Calendria as a heat source for concentrating stillage after decanter. The vapours of first Calendria are used as heat source for next Calendria. In rectifier column rectified spirit draw is taken out from top trays and fed to refining column where mainly methanol impurities are separated. Pure ENA is obtained at bottom of Refining column, which is cooled and stored. The impure spirit from top of rectifier column and refining column are fed to Fusel oil column (Recovery Column). The final impure spirit cut is taken out from Fusel oil column. Balance alcohol is recycled to pre-rectifier column. The alcohol containing fusel oil from pre-rectifier and rectifier column is fed to fusel oil decanters. The washed alcohol is fed to the feed tank of fusel oil column.

The Distillation process is operated through PLC.

STILLAGE PROCESSING

The stillage from distillation section is then passed through decanter where cake and thin stillage are separated. The recovered thin stillage from decanter is concentrated in the evaporator till 38% concentration. The evaporator uses heat from distillation column for desired final concentration of stillage. The product from the evaporator is mixed with cake recovered from decanter. The mixture is sent to the dryer and the dried product is used as cattle feed. Part of the thin stillage [approximately 40% to 50%] is recycled to the process.

CHAPTER –VI: DISTILLERY PLANT AND MACHINERY SPECIFICATIONS

Vitthalrao Shinde Sahakari Sakhar Karkhana Ltd., Gangamainagar, Post. Pimpalner, Tal. Madha, Dist. Solapur has decided to install 45KLPD grain based distillery plant based on latest technology to produce R.S. or ENA.

6.1: The basis of design & performance parameters

Sr. No.	Particulars		
1.	Plant capacity	45 KLPD grain based distillery plant to produce R.S. OR ENA	
2.	Rectified spirit +I.S.	42.75 KLPD R.S. plus 2.25 KLPD I.S.	
3.	ENA + TA	42.30 KLPD ENA plus 2.70 KLPD I.S.	
4.	R.S./ENA strength	96% v/v	
5.	Plant working days	330 days	
6.	Theoretical Generation of CO ₂	~ 35 - 36 TPD	
7.	Process	Fermentation Distillation Evaporator	Batch Multipressure Integrated
8.	Feed stock - Grain	Maize / Broken Rice / Sorghum Avg. Composition - Starch 68%, Fiber 3%, Moisture 11%, Protein 9%.	
9.	Clean grain	110 TPD	
10.	DDGS produced (Without considering losses & 100% Conversion Efficiency)	28 - 30 TPD	
11.	Efficiency	Liquefaction Fermentation Distillation	99% 90% 98.5%
12.	Alcohol % in Fermented wash	9 % v/v	

6.2: Utility requirements

UTILITY		
1)	Steam – 3.5 Kg/cm ² (g) @ 148 ^o C at Steam chest	
	Distillation (ENA Mode)	6,000 Kg/hr (3.2 Kg/lit of Total Spirit)
	Integrated Evaporator	Nil
	Steam – 3.5 Kg/cm ² (g) @ Superheated Temperature (Turbine Exhaust)	
	Liquefaction	656 Kg/hr (0.35 Kg/lit of Total Spirit)
	DDGS Dryer (designed to operate on saturated temperature)	3,565 Kg/hr (1.9 Kg/lit of Total Spirit)
2)	Make up Raw water requirement – Considering Captive Power Plant	405M ³ /day (After recycle of process condensate and thin slope) (8.5-9 Lit/Lit of Total spirit)
3)	Cooling water circulation - Fermentation @ ΔT 3 ^o C Liquefaction, Distillation & Evaporator@ ΔT 8 ^o C	225 M ³ /hr 600 M ³ /hr
4)	Make up DM water - Distillation, Boiler & DS (Depends on Alcohol quality)	105 – 110 M ³ /day
5)	Soft water - (Subject to Ambient Temperature)	430-440 M ³ /day (9-10 Lit/Lit of Total Spirit)
6)	Compressed Air	6 bar (g) with dew point of – 40 ^o C dew point dryness. Free from particulate matter, suitable for instruments.
7)	Electricity - 415 V/4 Wire / 3 Phase Frequency: 50 Hz – Estimated Power Consumption in KWh	
	Grain Silo, Grain Handling & Milling, Liquefaction, Fermentation, Multipressure Distillation & Integrated Evaporator, Stillage Handling & decantation, DDGS Dryer, Cooling Towers, Compressor, Captive Power plant., Water Treatment Plant, Effluent Treatment plant	1,400

8)	Chemical required for process	a. Alpha Amylase b. Glucoamylase c. Lime d. Caustic Soda	1.55 Kg/KL 1.55 Kg/KL 2.00 Kg/KL 10.0 Kg/KL
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Installation	Site Area - 16 to 18 Acres
Indoor	Grain Handling & Milling – Non-Flameproof Liquefaction – Non-Flameproof Fermentation – Non-Flameproof Distillation – Flameproof Integrated Evaporator – Flameproof DDGS Dryer - Non-Flameproof
Outdoor	Grain Silo – Non-Flameproof Cooling Towers – Non- Flameproof Water Treatment – Non- Flameproof Effluent Treatment – Non-Flameproof Receiver & Storage - Flameproof

6.3 Required parameters for water

Process water

Parameter	Unit	Value
pH	-	7 - 8
Chloride (Cl-) (Expressed as NaCl)	Mg/Lit.	< 25
H ₂ S	Mg/Lit.	Nil
Residual free Chlorine	Mg/Lit.	< 1
Silica (SiO ₂)	Mg/Lit.	< 25
Total Hardness (Expressed as CaCO ₃)	Mg/Lit.	< 200
Turbidity	NTU	< 5 PPM
Total Dissolved Solids	Mg/Lit.	< 500
Total germs	Nos./ml	< 60 CFU
Coli form Bacteria	Nos./ml	Nil
E. Coli	Nos./ml	Nil

Soft water

Parameter	Unit	Value
pH	-	7 - 8
Chloride (Cl-) (Expressed as NaCl)	Mg/Lit.	< 25
H ₂ S	Mg/Lit.	Nil
Residual free Chlorine	Mg/Lit.	< 1
Silica (SiO ₂)	Mg/Lit.	< 25
Total Hardness (Expressed as CaCO ₃)	Mg/Lit.	< 5
Turbidity	NTU	< 5 PPM
Total Dissolved Solids	Mg/Lit.	< 500

DM water

Parameters	Unit	Value
Hardness	PPM (Max.)	< 1
pH at 25°C (Before Correction)		5.5-6.5
Turbidity	% v/v	Nil
Chloride Contain	PPM (Max.)	Nil
Silica		< 1

6.4 Finished Product Quality

The material shall comply with the requirements prescribed in the following table.

1) Qualitative Specifications for Rectified Spirit (R.S.) :-

Sr. No.	Characteristic	Requirement of Rectified Spirit
1.	Ethanol content (Minimum), % v/v at 15.6 ⁰ C	96%
2.	Acidity as acetic acid, mg/100 ml (Max.)	2
3.	Esters as ethyl acetate, mg/100 ml (max.)	10
4.	Aldehydes as acetaldehyde, mg/100 ml. (Max.)	5
5.	Residue on evaporation, mg/100 ml. (Max.)	2
6.	Methanol, mg/100 ml. (Max.)	5
7.	Butanol – 1	Nil
8.	Butanol – 2	Nil
9.	Isobutanol - mg/100 ml. (Max.)	5
10.	Isopentanol - mg/100 ml. (Max.)	1

11.	N-Propanol & Isopropanol, mg/100 ml. (Max.)	10
12.	Copper as Cu, mg/100 ml. (Max.)	0.3
13.	Lead as Pb, mg/100 ml. (Max.)	0.05
14.	Furfural	Nil
15.	KMNO ₄ reaction, time, minutes (Min.)	30
16.	The spirit shall be suitable for potable purpose & meet norms of Organoleptic taste	Minimum score 6.5/8 scale

2) Qualitative Specifications for Extra Neutral Alcohol (ENA)

Sr. No.	Characteristic	Requirement of Extra Neutral Alcohol (ENA)
1.	Ethanol content, % v/v at 15.6 ⁰ C (Min.)	96.0
2.	Miscibility with water	Miscible
3.	Alkalinity	Nil
4.	Acidity (as CH ₃ COOH), Mg/100 ml. Max.	1.25
5.	Residue on evaporation, Mg/100 ml. Max.	2.00
6.	Esters (as CH ₃ COO ₂ H ₅), Mg/100 ml. Max.	2.00
7.	Lead as Pb, Mg/100 ml, Max.	Nil
8.	Methyl alcohol content, PPM, Max.	5
9.	Furfural content	To pass test
10.	Aldehydes (as CH ₃ CHO), Mg/100 ml. Max.	0.5
11.	Permanganate reaction, time, minutes (Min.) at 15 ⁰ C	50
12.	Copper as Cu, Mg/100 ml. (Max.)	0.2
13.	Fusel oil content, Mg/100 ml., Max.	1.5
14.	It should meet the Organoleptic taste norms, quality as required for companies like USL/ABD or any other reputed buyers	Minimum 6.5/8 point score.

6.5: SPECIFICATION OF CIVIL AND STRUCTURALWORK FOR PROPOSED 45 KLPD GRAIN BASED PLANT TO PRODUCE R.S. OR ENA

The following are to be considered:-

- Wind and soil test to be considered. Details of soil strata & load data.
- All design will be as per ISI specification and drawings are to be approved by factory /electrical inspectorate /safety inspectorate weights & measurement inspectorate etc.
- The plinth level of distillery building will be at min 0.75 mtr height from developed ground level and it is to be built by brick masonry. For ground floor flooring of M10 grade (CC1:3:6) as a base concrete is to be made and it's IPS shall be 50 mm of M15 grade (CC1:2:4). Plinth foundation should carry the load of 4 M height wall safely.
- Staircase – M.S. (Chequered plate with supports/grating of 5 mm thick) staircase of 1M wide, 150 mm risers and 300 mm treads with a landing at every 3M maximum and rails provided on both sides, thus two staircases are provided up to top floor of plant. The staircases have to be inside the building.
- All floors (except ground) of the distillation building should be with MS grating of 5 mm thickness and each floor height should be minimum 4 M & Chequered plate at a condenser floor of 6 mm thickness.
- All distillation columns accessed from flooring (grating)
- The roof of the structures (fermentation, distillation, receivers) must be covered totally by pre-coated sheets (Pre-painted galvano loom sheet i.e. PPGL sheets) of 0.5 mm thickness.
- Pre-coated sheet should cover roofing with extension on both side minimum as 0.75 M. Similarly pre-coated louvers of 0.75M size & 0.5 mm thickness provided for every floor.
- Receivers' tanks for R.S. & ENA in a structure of which roof covered in pre-coated sheets and side walls of structure should be constructed in brick masonry up to the 2.5 M height and above burnt brick masonry (BBM) wall standard chain link fencing up to roof.

- Bulk storage tanks – Bulk storage tanks will have dyke wall with chain link fencing (2.5 M ht. brick wall and above it 1.5 M ht. chain link with mild steel door with lock and key arrangement).
- Boundary wall to building (The details of wall are as 0.345 M width, 2.1M brick masonry height and above it made out of brick masonry above ground level 1 M height and above it 1 M vertical & 0.5 M slanting barbed wire fencing (5 rows & 3 rows barbed wires respectively) with MS angles (50 mm x 50 mm x 6 mm size) at 2.5 M center to center & embedded 0.3M length in concrete block of 0.345 M x 0.45 M x 0.45 M size in masonry walls, the MS angles should be coated with one coat of primer and two coats of oil paint. The wall is to be painted in two coats of cement paint.
- Building painting – Oil bond distemper inside and cement colour (Showcem) outside.
- All structure work to be painted by one coat primer and two-coat first grade enamel paints – Berger first grade colour.
- Cooling tower basin provided in RCC
- Plant building lighting as per norms & as per Electrical inspectorate / factory inspectorate norms.
- Room for Air compressor, PLC & MCC
- The layout should include –
 - i) Distillation inclusive of staircases (2 Nos.) within building to be covered by pre-coated sheets & with extension on both sides as minimum 0.75 M. The distillation section shall be 20 M x 20 M. In this house there should be sufficient floors for easy access to all parts/segments of the distillation columns, condensers, coolers etc. & should have proper pre-coated sheets roof & cladding on the operating floor. Other floor should have louvers cladding.
 - ii) Receivers room with pump.
 - iii) Bulk storage tank
 - v) Tanker loading platform outside of the storage tank

- vi) Cooling towers.
- vii) Administration building – Existing
- viii) Distance between flameproof and non-flame proof area min. 15M.

The layout will take into account the working space & safety requirement of Factory Inspectorate, Govt. of Maharashtra State.

Structural Work –

Wind and soil test to be considered. Details of soil data and load data are to be ascertained by purchaser.

Sr. No.	Section	Civil work	Structural work
1.	Grain Handling & Milling	RCC column and brick masonry works around periphery up to bottom of truss with ventilation. Staircase in RCC, (i.e. window). Equipments foundations, Blowers foundation	Providing roof on top, trusses,
2.	Liquefaction & Fermentation	Structure building foundation. Equipment foundation, Pumps, PHE foundation,	Structural building enclosed by providing roof. Operating floor and other floors with grating for ease of operation. Hand rail, Top Roof, truss, M.S. (grating) staircase on both sides as per our GA.
3.	Distillation	RCC slab including staircase column up to 5/6 M level above 5/6 M Structure Building foundation. Equipment foundation, Column, Pumps, PHE foundation	Structural building above 5/6M level enclosed by providing roof. Condenser floor covered with Chequered plate and other floors with grating for ease of operation. Hand rail, M.S. (grating) staircase on both sides. All floors kept open, roofing depending upon span.

4.	Evaporator	RCC column & Slab up to 6 M level Structure Building Foundation. Equipment Foundation, Pumps, PHE Foundation,	Structural building enclosed by providing roof. All floors with grating. Hand rail, M.S. (grating) staircase on both sides. Roofing depending upon span.
5.	DDGS Dryer & Decantation	RCC column and brick masonry works around periphery up to bottom of truss with ventilation (i.e. window). Dryer Foundation, Equipments Foundations, Blowers Foundation	Providing roof on top, trusses, M.S. (grating) staircase as per our GA.
6.	Cooling Tower basin	Cooling tower basin should be provided in RCC. This shall be followed by water proof plaster from inside and outside with minimum 8 min water hold up of circulation rate. It should be provided with water proofing coating treatment to inside. This shall be followed by water proof plaster from inside and outside.	
7.	Alcohol receiver & storage section	RCC column and brick masonry works around periphery with ventilation as per safety norms. Tank, Pumps Foundation. Pipe Support Foundations.	Storage section open to sky
8.	Piping	Yard Piping & Steam Piping Support Foundation as per design & drawing submitted by Mojj.	
9.	MCC Room, PLC Room, Laboratory	MCC room with slab, PLC Room with Slab above MCC Room, Laboratory with Slab with Sanitary, tiles, Plumbing.	
10.	Administrative	Administrative Building Distillery Manager Office, Excise Office with	Existing

		Furniture's, Electrification, sanitary, tiles, plumbing. Weigh Bridge Foundation & room. Security Cabin, Time Office, Store, Godown, Work shop, Toilet Blocks.	
11.	Miscellaneous	Cable Trenches, Internal & External Gutter, Channels for Rain Harvesting Water. Site Development, Leveling, Cleaning. Green Belt Development. Main Gate, Side Gates, Compound Wall & Fencing. Earthing Pits for Civil, All other necessary civil work related for plant & which are not covered above.	

**6.6: TECHNICAL SPECIFICATIONS FOR 45 KLPD GRAIN BASE
DISTILLERY PLANT TO PRODUCE RECTIFIED SPIRIT OR EXTRA
NEUTRAL ALCOHOL**

**6.6.1 TECHNICAL SPECIFICATION FOR GRAIN SILO, GRAIN HANDLING
AND MILLING SECTION**

Grain Silo with accessories – Capacity 2500 MT each

Sr. No.	Description	Nos.
1.	Receiving Hopper: Mild Steel, grating top, magnetic grating bottom.	1 No.
2.	BUCKET ELEVATORS –25 TPH - Bucket elevator for Pre-cleaner. Belt and bucket type, with top hood, bottom boot and twin leg type intermediate casing.	1 No.
3.	PRE-CLEANER: 25 TPH with aspiration, blower, double deck cleaning. Cyclone dust collector with rotary air lock valve.	1 Set.
4.	Galvanized corrugated silo, Flat bottom, which can hold 2500 MT each grain with Bulk Density 700 Kg/m ³ with 5% compaction.	2 Nos.
5.	BUCKET ELEVATORS – 25 TPH - Bucket Elevator Grain Silo. Belt and bucket type, with top hood, bottom boot and twin leg type intermediate casing.	1 No.
6.	Accessories- Level switches, Aeration system with fan, supporting frames, perforated sheets etc. Sweep auger. Discharge gates (manually operated sliding type).	2 Sets
7.	CHAIN CONVEYORS – Conveyor supplied with Chain and sprocket type, casing, drive end, tension end.	1 Set
8.	SUPPORTING STRUCTURALS – Supporting tower for bucket elevator for grain silo and catwalk for overhead chain conveyor.	1 Set
9.	CHUTES & DUCTINGS – Necessary chutes for all transfer point.	1set
10.	M.C.C. panel, cables – with cable trays, inter locking arrangement will be provided.	1 set.
11.	Instrumentation Separate small control panel to be provided in the grain unloading area having start / stop push buttons.	1 set.

GRAIN HANDLING & MILLING

Sr. No.	Description	Capacity	MOC	Nos.
1.	Bucket Elevator 1 - For elevating grain from chain conveyor to De-stoner.	6 MT/hr	MS	1 No.
2.	De-stoner – for remove stone from grain. Finer Separation and based on flowing dry granular material over inclined, vibrating screen covered deck. Complete with aspiration system	6 MT/hr	MS	2 Nos.
3.	Bucket Elevator 2 – For elevating grain from de-stoner to magnetic separator.	6 MT/hr	MS	1 No.
4.	Magnetic Separator - For removal of ferrous material from grain.	6 MT/hr	MS	1 No.
5.	Bucket Elevator 3– For elevating grain from magnetic separator to hammer mill	6 MT/hr	MS	1 No.
6.	Feed Hopper – For feeding of grain to Hammer mill.		MS	1 Set
7.	Hammer Mill – For grinding of grain into flour. Direct drive motor. Flexible coupling with safety shield. Top centre feed inlet with manual directional gate. Sets of screen, quick change spring loaded shock absorbent screen carriage. Automatic safety door lock – manual.	6 MT/hr	MS	1 No. Working (Imported) + 1 no. Standby (Indigenous)
8.	Conveying System – Screw Conveyor to convey the flour from Hammer mill to Bucket elevator for Flour Silo.		MS	1 No.
9.	Bucket Elevator 4 - For elevating grain from screw conveyor to flour silo.	6 MT/hr	MS	1 No.
10.	Flour Bins – Storing of flour	2 Hrs. Residence Time	MS	1 set

11.	Weighing Hopper – For weighing of flour before feed to liquefaction Load cell system for weigh indication of flour.			1 No.
12.	Screw Conveyor – To convey the flour to Liquefaction		MS	1 No.

6.6.2 TECHNICAL SPECIFICATION FOR SLURRY PREPARATION AND LIQUEFACTION

Sr. No.	Description	Capacity	MOC	Nos.
1.	Blunger tank	Standard	Contact parts SS-304, Non –contact part in MS	1 No.
2.	Mixing tank	15M ³	Contact parts SS-304, Non –contact part in MS	1 No.
3.	Liquefaction tank	35M ³	Contact parts SS-304, Non –contact part in MS	1 No.
4.	Saccharification tank	25M ³	Contact parts SS-304, Non –contact part in MS	1 No.
5.	Agitator for Sr. No. 2 to 4	Suitable	Contact parts AISI-304	Lot
6.	Hot water tank	15M ³	Contact parts SS-304, Non –contact part in MS	1 No.
7.	Lime mixing tank	1M ³	MS	1 No.
8.	NaOH tank	1M ³	MS	1 No.
9.	Enzyme Dosing system	1 No. Each for ENS & ENL		
10.	Flash vessel	Suitable	Contact parts SS-304, Non –contact part in MS	1 No.
11.	Jet cooker		Contact parts SS-304	1
12.	Mash cooler - Liquefaction slurry	PHE Gap – 8 – 10 mm	Plate – SS-316 Frame - MS	1 Working
13.	Mash cooler - Saccharification slurry	PHE Gap – 8 – 10 mm	Plate – SS-316 Frame - MS	1 W.+ 1 Stand by for Both

14.	Holding Tank		Contact parts SS 304, Non – contact parts in MS	1 No.
15.	Instruments & Control			Lot
16.	Piping & Valves			Lot

Pumps & Motors

Sr. No.	Pump	Type	MOC	Nos.
1.	Mixing slurry transfer pump	Centrifugal	Contact Part – AISI 304	1 + 1
2.	Liquefaction slurry transfer pump	Centrifugal	Contact Part – AISI 304	1 + 1
3.	Fermentation feed pump	Centrifugal	Contact Part – AISI 304	1 + 1
4.	NaOH / Liquid Ammonia pump	Centrifugal	Contact Part – AISI 304	1 + 1
5.	Hot water transfer pump	Centrifugal	Contact Part – AISI 304	1 + 1

6.6.3 TECHNICAL SPECIFICATION FOR YEAST PROPAGATION AND FERMENTATION SECTION

Sr. No.	Description	Specification	MOC	Nos.
1.	Pre – Fermenters	40 M ³	Contact parts SS-304, Non – contact parts in MS	2 Nos.
2.	Fermenters	250 M ³	Contact parts SS-304, Non – contact parts in MS	5 Nos.
3.	Beer Well	250 M ³	Contact parts SS-304, Non – contact parts in MS	1 No.
4.	Agitator for fermenters and beer well	Suitable	Contact parts SS-304	Lot

5.	CIP Tank	10 M ³	Contact parts SS-304, Non – contact parts in MS	2 Nos.
6.	CO ₂ Scrubber	Sieve Tray	Contact parts SS-304, Non – contact parts in MS	1 No.
7.	Pre fermenters cooler	PHE Gap - 4 to 4.5 mm	Plate – SS-316 Frame - MS	2 Nos.
8.	Fermented cash cooler	PHE Gap - 4 to 4.5 mm	Plate – SS-316 Frame - MS	5 Nos.
9.	Instrumentation			1 set
10.	Piping & Valves			1 set

Pumps & Motors

Sr. No.	Pump	Type	MOC	Nos.
1.	Fermented wash recirculation pump	Centrifugal	Contact parts – SS- 304	5+ 1
2.	CIP Pump with motor	Centrifugal	Contact parts – SS- 304	1 + 1
3.	Pre-fermenter pump	Centrifugal	Contact parts – SS- 304	1 + 1
4.	Fermented wash transfer pump	Centrifugal	Contact parts – SS- 304	1 + 1
5.	Liquid Ring Blower for Fermentation	Water Ring Type	Contact parts – SS- 304	1 + 1

6.6.4: TECHNICAL SPECIFICATION FOR MULTIPRESSURE DISTILLATION SECTION

COLUMNS

Sr. No.	Description	Specification	MOC	Nos.
1.	CO ₂ Stripping column	Diameter – 950 mm RH grid 6 Nos.	Contact parts SS-304	1 No.
2.	Stripping column	Diameter – 1650 mm RH grid 22 Nos.	Contact parts SS-304	1 No.
3.	Pre-rectifier Cum Exhaust column	Pre-rectifier Diameter – 1550 mm Bubble Cap 55 Nos. Exhaust - Dia. – 450 mm Bubble 12 Nos.	Contact parts SS-304	1 No.
4.	Extraction column	Diameter – 1100 mm Bubble Cap 44 Nos.	Contact parts SS-304	1 No.
5.	Rectifier column	Diameter – 1400 mm Bubble Cap 72 Nos.	Shell – SS 304; 38 Trays SS 304; 34 Trays DOC	1 No.
6.	Refining column	Diameter – 900 mm Bubble Cap 50 Nos.	Shell – DOC, Trays - DOC	1 No.
7.	Fusel Oil column	Diameter – 900 mm Bubble Cap 72 Nos.	Contact parts SS-304	1 No.

REBOILERS

Sr. No.	Description	Specification	MOC	Nos.
1.	Stripper Reboiler	Shell & Tube Tube – OD 38.1 mm X 1.6 mm thk.	Contact parts SS-304	1 No.
2.	Exhaust Reboiler	Shell & Tube Tube – OD 25.4 mm X 1.6 mm thk.	Contact parts SS-304	1 No.

3.	Extraction Reboiler	Shell & Tube Tube – OD 25.4 mm X 1.6 mm thk.	Contact parts SS-304	1 No.
4.	Rectifier Reboiler	Shell & Tube Tube – OD 25.4 mm X 1.6 mm thk.	Contact parts SS-304	1 No.
5.	Refining Reboiler	Shell & Tube Tube – OD 25.4 mm X 1.6 mm thk.	Contact parts SS-304	1 No.
6.	FOC Reboiler	Shell & Tube Tube – OD 25.4 mm X 1.6 mm thk.	Contact parts SS-304	1 No.
7.	HCC Reboiler	Shell & Tube Tube – OD 25.4 mm X 1.6 mm thk.	Contact parts SS-304	1 No.

CONDENSERS

Sr. No.	Description	Specification	MOC	Nos.
1.	CO ₂ Stripper Main Condenser	Shell & Tube Tube – OD 25.4 mm X 1.2 mm thk.	Contact parts SS-304	1 No.
2.	CO ₂ Stripper Vent Condenser	Shell & Tube Tube – OD 25.4 mm X 1.2 mm thk.	Contact parts SS-304	1 No.
3.	Beer Heater	Shell & Tube Tube – OD 25.4 mm X 1.2 mm thk.	Contact parts SS-304	1 No.
4.	Pre-rectifier Main Condenser	Shell & Tube Tube – OD 25.4 mm X 1.2 mm thk.	Contact parts SS-304	1 No.
5.	Pre-rectifier Vent Condenser	Shell & Tube Tube – OD 25.4 mm X 1.2 mm thk.	Contact parts SS-304	1 No.
6.	Rectifier Vent Condenser	Shell & Tube Tube – OD 25.4 mm X 1.2 mm thk.	Contact parts SS-304	1 No.

7.	Refining Main Condenser	Shell & Tube Tube – OD 25.4 mm X 1.6 mm thk.	Contact Parts DOC	1 No.
8.	Refining Vent Condenser	Shell & Tube Tube – OD 25.4 mm X 1.6 mm thk.	Contact Parts DOC	1 No.
9.	FOC Main Condenser	Shell & Tube Tube – OD 25.4 mm X 1.2 mm thk.	Contact Parts S304	1 No.
10.	FOC Vent Condenser	Shell & Tube Tube – OD 25.4 mm X 1.2 mm thk.	Contact parts SS-304	1 No.

COOLERS

Sr. No.	Description	Specification	MOC	Nos.
1.	ENA Cooler	Shell & Tube Tube – OD 25.4 mm X 1.6 mm thk.	Contact Parts DOC	1 No.
2.	TA Cooler	Shell & Tube Tube – OD 25.4 mm X 1.2 mm thk.	Contact parts SS-304	1 No.
3.	FO Cooler	Pipe & Pipe	Contact parts SS-304	3 Nos.

TANKS

Sr. No.	Description	Specification	MOC	Nos.
1.	PRC Feed tank	Suitable	AISI304	1 No.
2.	Pre-rectifier reflux tank	Suitable	AISI304	1 No.
3.	Rectifier Reflux tank	Suitable	AISI304	1 No.
4.	FOC Feed tank	Suitable	AISI304	1 No.
5.	Steam Condensate tank	Suitable	Mild Steel	1 No.

6.	Fusel Oil Decanter	Suitable	AISI 304	2 Nos.
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MISCELLANEOUS

Sr. No.	Description	Specification	MOC	Nos.
1.	Alcohol Scrubber	Packed column	AISI 304	1
2.	Feed Preheater	PHE	Plate AISI 304 / Frame MS	Lot
3.	PLC system, Instrumentation			Lot
4.	Piping & Valves			Lot

Pumps & Motors

Sr. No.	Pump	Type	MOC	Nos.
1.	CO ₂ Stripper Reflux pump	Centrifugal	Contact parts SS-304	1 + 1
2.	Stripper Bottom pump	Centrifugal	Contact parts SS-304	1 + 1
3.	Pre-rectifier Reflux pump	Centrifugal	Contact parts SS-304	1 + 1
4.	Extraction Feed pump	Centrifugal	Contact parts SS-304	1 + 1
5.	Rectifier Feed pump	Centrifugal	Contact parts SS-304	1 + 1
6.	Rectifier Reflux pump	Centrifugal	Contact parts SS-304	1 + 1
7.	Rectifier Bottom pump	Centrifugal	Contact parts SS-304	1 + 1
8.	Refining Reflux pump	Centrifugal	Contact parts SS-304	1 + 1
9.	Product Transfer pump	Centrifugal	Contact parts SS-304	1 + 1

10.	IS feed Pump for FOC	Centrifugal	Contact parts SS-304	1 + 1
11.	FOC Reflux pump	Centrifugal	Contact parts SS-304	1 + 1
12.	FOC Bottom pump	Centrifugal	Contact parts SS-304	1 + 1
13.	Steam Condensate Transfer pump	Centrifugal	Contact Part – CI Case –CI	1 + 1
14.	Axial Flow pump	Force centrifugal	Contact parts SS-304	1
15.	Blower for Dryer Vapour	Centrifugal	Contact parts SS-304	1 + 1
16.	Vacuum pump	----	Contact parts SS-304 Case –CI	1 + 1

6.6.5: TECHNICAL SPECIFICATION FOR UTILITIES

COOLING TOWER

Sr. No.	Description	Nos.	Technical Data	M.O.C
1.	Cooling Towers for Fermentation	1	$\Delta T = 3^{\circ}C$ Induced Draft	Wooden
2.	Cooling Towers for Liquefaction, Distillation & Integrated Evaporator	1	$\Delta T = 8^{\circ}C$ Induced Draft	Wooden

Pumps & Motors

Sr. No.	Pump	Type	Shaft Seal	MOC	Nos.
1.	Circulation Pump for Fermentation	Centrifugal Split Case	Gland Packing	CI	1 + 1
2.	Circulation Pump for Liquefaction, Distillation & Evaporator	Centrifugal Split Case	Gland Packing	CI	2 + 1

MISCELLANEOUS

Sr. No.	Description	Technical Data	Nos.
1.	Air Compressor	Type - Reciprocating Max. Working Pressure – 7 Bar Air system, Integrated Air dryer system, Drive Arrangement & Air Filter.	1 + 1
2.	Sealing Water Recycle Systems	Tank – Suitable Capacity with SS 304 Contact Parts, 1 No. Pump – Suitable Capacity, Contact part in SS 304, 1 + 1 Nos., PHE – Plate in SS 304, End Frame in Mild Steel, 1 No.	1 Lot
3.	Vacuum Water Recycle Systems	Tank – Suitable Capacity with SS 304 Contact Parts, 1 No. Pump – Suitable Capacity, Contact part in SS 304, 1 + 1 Nos., PHE – Plate in SS 304, End Frame in Mild Steel, 1 No.	1 Lot

6.6.6: TECHNICAL SPECIFICATION FOR RECEIVER & STORAGE SECTION

RECEIVERS

Sr. No.	Description	Technical Data	M.O.C	Nos.
1.	Day Receiver Tank for R.S.	Type : Vertical / Cylindrical Capacity – 50M ³	Mild Steel	3
2.	Day Receiver Tank for ENA	Type : Vertical / Cylindrical Capacity – 50M ³	Mild Steel	3
3.	Day Receiver Tank for TA	Type : Vertical / Cylindrical Capacity – 5M ³	Mild Steel	3

ALCOHOL STORAGE

Sr. No.	Description	Technical Data	M.O.C	Nos.
1.	Bulk Storage Tank for R.S.	Type : Vertical / Cylindrical Capacity – 700 M ³	Mild Steel	2
2.	Bulk Storage Tank for ENA	Type : Vertical / Cylindrical Capacity – 700 M ³	Mild Steel	2
3.	Bulk Storage Tank for TA	Type : Vertical / Cylindrical Capacity –100 M ³	Mild Steel	1
4.	FO Storage Tank	Type : Vertical / Cylindrical Capacity –10 M ³	Mild Steel	1

ACCESSORIES

Sr. No.	Description	Nos.	Technical Data	M.O.C
1.	Vent Condenser – For Bulk Storage tanks	1 Lot	Shell & Tube	Mild Steel
2.	Flame Arrestor	1 Lot.		
3.	Piping & Valves	1 Lot		Mild Steel

Pumps & Motors

Sr. No.	Pump	Nos.	Type	Shaft Seal	MOC
1.	Issue cum Transfer pump for R.S./ENA	1 + 1	Centrifugal 40 M ³ /hr	Single Mech.	Contact Parts CF8
2.	Issue cum Transfer pump for IS	1 + 1	Centrifugal 20 M ³ /hr	Single Mech.	Contact Parts CF8

6.6.7 PIPING & VALVES

Piping

Liquefied Slurry	SS-304
Fermented Mash	SS-304
NaOH	SS-304
CO ₂	SS-304
Effluent from Bottom of Stripper	SS-304
Instrument Air	GI
ENA/TA	SS-304 up to Cooler then MS
Fusel Oil	SS-304 up to Decanter then MS
Impure Spirit	SS-304 up to Cooler then MS
Steam	MS 'C' Class
Steam Condensate	MS 'C' Class
Spent Lesse	SS-304
Cooling Water Supply	MS 'B' Class
Cooling Water Return	MS 'B' Class
Vacuum	SS-304
Process Condensate	SS-304
Process Water	MS 'C' Class
Soft Water	MS 'C' Class
DM Water	MS 'C' Class
ERW Piping	- Sch 10 up to 50 NB
SS Pipe Sch	- Sch 5 above 50 NB

Valves

Description	Less than 50 NB	More than 50 NB
Slurry	Ball valve CS body with SS 304 ball	Butterfly valve CI Body & SS-304 disc.
Fermented Wash	Ball valve SS 304 contact parts	Butterfly valve with SS-304 disc.
Process & cooling water	Ball valve with CS body	Butterfly valve with CS body and SGI disc.
Air	Ball valve with contact parts SS304 and Body CS	-
CO ₂	-	Butterfly valve with CI body and SS-304 disc
Stillage	Ball valve SS 304 contact	Butterfly valve with CI body and SS-304 disc
ENA	Ball valve SS-304 contact	Butterfly valve with CI body and SS-304 disc
Spent Lesse	Ball valve SS-304 contact	Butterfly valve with CI body and SS-304 disc
Steam Condensate	Gate valve with CI Body	Gate valve with CI Body

Pipe sizing:

Velocities to be considered for pipe sizing irrespective of

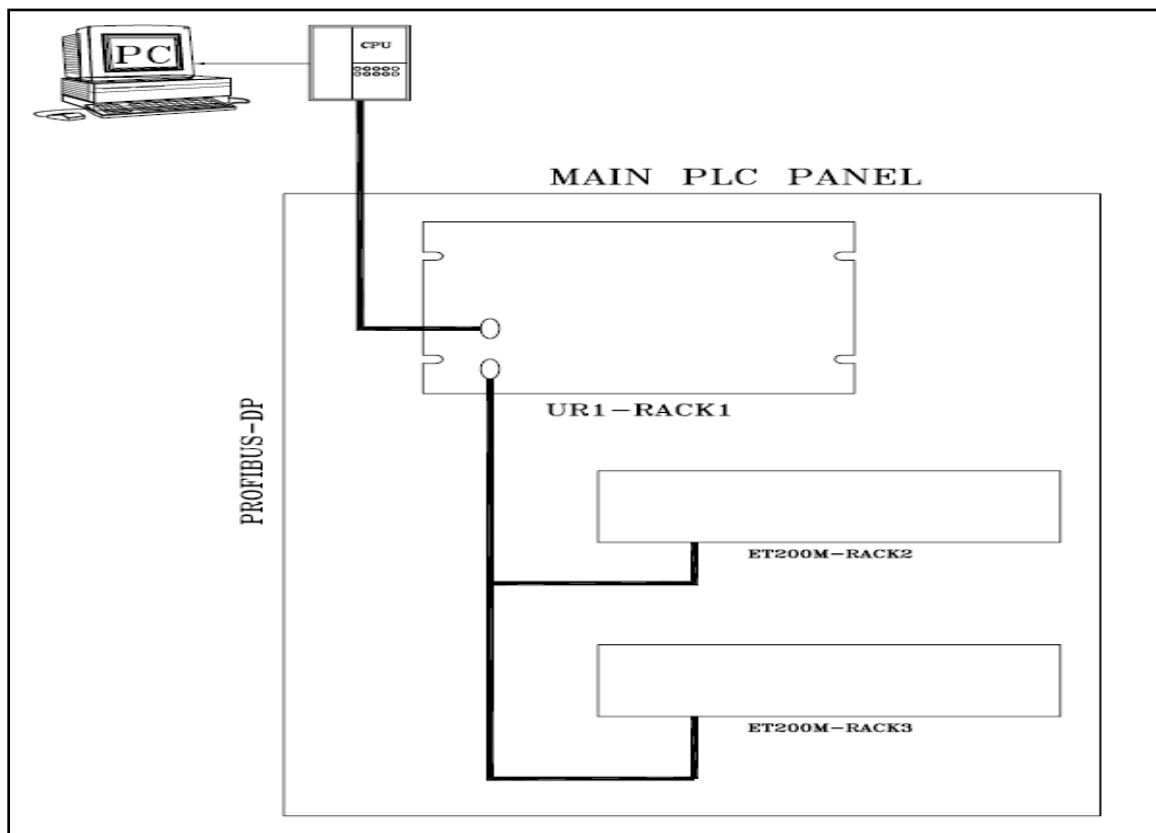
Pressures are as under-

Steam	:	25 – 30 m/sec
Process vapor	:	15 - 20 m/sec
Process vapor		
Under vacuum	:	up to 25 m/sec
Pumped liquids	:	1.2-1.8 m/sec
Gravity flow	:	0.8-0.9 m/sec

6.6.8: TECHNICAL SPECIFICATION FOR INSTRUMENTATION & CONTROL

DETAILS OF INSTRUMENT CONTROL SYSTEM

SCADA stands for “Supervisory Control and Data Acquisition”, a computer system for gathering and analyzing real time data. As the name indicates, it is not a control system in itself, but rather focuses on the supervisory level. It is a purely software package that is positioned on top of the hardware to which it is interfaced, in general via the PLC or other communication hardware modules.



All the control (field) instruments are connected through this software interface to Control logic programmed in a monitor in control room, from where proper monitoring of the various parameters on the field can be done. Thus, very less human intervention is ensured so as to run the plant in a trouble-free manner.

SPECIFICATION FOR PLC SYSTEM		
1	No. Of Input / Output	SPECIFICATION
a	Digital Inputs (24 VDC)	Qty will be provided after Detail Engineering
b	Digital Outputs (24 V / 0.5A DC)	
c	Analog Input Cards (RTD)	
d	Analogue Inputs (4 - 20 mA)	
e	Analogue Outputs (4 - 20 mA)	
1	PLC System	
2	Operating Station	1 No. Engineering Cum Operating Station
3	Detailed Bill of Material	
a	I/O Cards	Will be provided as per requirement with 30% spare
b	Racks	A per requirement
c	Terminal Block (Low Voltage)	Provided as per module
d	Filler Block Terminal Cover	Provided
e	Communication Protocol	As per System Make
f	Communication Cable	As per engineering
6	Redundancy	
a	IO Cards	Not Applicable
b	Communication	Not Applicable
c	CPU (Controller)	Not Applicable
b	Power	Not Applicable

SPECIFICATIONS FOR ICP PANEL FOR FERMENTATION & DDGS DRYER INDICATION ONLY	
Type	Fixed, Free Vertical Standalone Type
Operation	Front Operated with Single door, door lock rittal type
Location	Outside. (Open Area In Fermentation Section)
Enclosure Protection	IP 52
Cable Entry	From Bottom through detachable gland plates, 3mm Thk
Fabrication	14 / 16 G CRCA Sheet
Painting	Powder Coating with 7 - Tank Process
Colour Shade	Siemens Grey, RAL - 7032
Base Frame	75 mm ISMC
Lifting Lugs	To be Provided as Required
Panel Dimensions	Suitable
Power Supply	230 VAC, 50 Hz
Control Supply	230 VAC, 50 Hz / 24 VDC

6.6.9: List of Instrumentation

LIQUIFICATION		
1	Temp Element	Lot
2	Flow Meters – Glass Tube Rotameters, Metal Tube Rotameters, Magnetic Flow Meter	
3	Pressure Gauges	
4	Control Loops	
FERMENTATION		
1	Temp Element	Lot
2	Flow Meters – Glass Tube Rotameters, Magnetic Flow Meter	
3	Pressure Gauges	

DISTILLATION		
1	Temp Element	Lot
2	Flow Meters – Glass Tube Rotameters, Metal Tube Rotameters, Magnetic	
3	Flow Meter	
4	Control Loops (Level, Pressure, Temp) included Transmitters	
5	Pressure Gauges	
EVAPORATOR		
1	Temp Element	Lot
2	Flow Meters – Glass Tube Rotameters, Magnetic Flow Meter	
3	Control Loops (Level) included Transmitters	
4	Pressure Gauges	
DRYER		
1	Temp Element	Lot
2	Flow Meter	
3	Steam Control Loops included Transmitters	
4	Pressure Gauges	
COOLING WATER		
1	Temp Element	Lot
2	Pressure Gauges	

Control system

The closed loop control, interlock, sequence controls and data acquisition are performed in the control system.

PARTS INTERCHANGEABILITY

The system incorporates modular design using plug in assemblies.

Provide Run Time Software.

Universal removable terminal strips will be used to connect field wiring to individual circuit board assemblies.

SECURITY

Memory protect key switch is there to prevent alteration of program and configuration data through interface device.

SYSTEM SPECIFICATION

System hardware

The system offers following subsystems connected to it.

Communication hardware

- Communication within PLC system
- The system is reliable, high speed, and peer-to-peer communication.
- The BUS of IEEE standard and of latest version.
- The BUS system capable of being extended through a connection of Modem.
- PLC is provided with profibus communication.
- Communication with external device through TCP/IP protocol.

Control system

The closed loop control, interlock, sequence controls and data acquisition are performed in the control system.

Communication system

PC + Printer

PC

Make – HP/Equivalent

Intel Core I3 Processor / 4 GB RAM / 360 GB HDD

Accessories – Keyboard / Mouse / DVD Writer

Operating System – Windows Xp / Windows 7

Monitor – 21.5 inch LCD

License – User 1 Paper License

Printer with Scanner - 1 No

6.6.10: TECHNICAL SPECIFICATION FOR ELECTRICAL

SPECIFICATIONS FOR MCC PANEL -

Type	Compartmental, Free Vertical Standalone Type
Operation	Front & Back Operated
Location	Inside Control room
Enclosure Protection	Dust proof to IP- 42
Cable Entry	From Bottom/Top through detachable gland plates, 3mm Thk
Power Supply	3 Phase, Neutral, 415 VAC, 50 Hz
Control Supply	1 Phase, 230 VAC, 50 Hz
Metering Section	Voltmeter, Ammeter, KWH Meter & Indication Lamps with proper isolation, Swelctor Switches & necessary accessories as reqd.
Outgoing Feeders	All Outgoing Feeders should be with SFU design. For feeders having rating 7.5 KW star delta connection & above should be with ammeter
Fabrication	14 / 16 G CRCA Sheet
Painting	Powder Coating with 7 - Tank Process

PUSH BUTTONS

1	Type	Wall Mounted With Back Side Nut Bolting Provision.
2	MOC	LM 6 Alloy
3	Colour/ Finishing	Inside & Outside Epoxy Paint Shade 631 Of IS:5
4	Quantity	Suitable

Feeder Selection

0.5 HP to 7.5 HP	-	DOL
Above 7.5 HP	-	Star Delta

CABLE SPECIFICATION

Instrument / Control cable	
300/500 V Standard non compact tinned Copper Conductor with XLPE insulation, overall screened with AL MYLAR & DRAIN WIRE, EXTRUDED PVC ST2 INNERSHEATH,SINGLE GI Rounded wire Armour AND PVC ST2 Outer sheath	
For 24 & 5 Core Cable, all cores shall be colored Grey & Numbering shall be provided on each core insulation in Black Letters, for core Identification. For 3 Core Cable, cores shall be color coded with Brown + Black + Blue. Also for 2 Core Cable, cores shall be color coded with Blue + White. The same will be applicable for Pair & Triad cable. For Multi Pair & Triad Cables, all individual pairs / triads should be in Twisted form & with proper Numbering.	
Power cable	
C	1.1 KV, Aluminium / Copper Conductor, PVC Insulated, Inner Sheathed, Armoured & PVC Sheathed cables Conforming to IS:1554 (part I),
1	3 Core up to 2.5 mm ² Copper, Type - YWY
2	3 Core above 2.5 mm ² Aluminium, Type - YWY
For Cables above 200 mtr should be supplied in Drum	
Standard Drum length should be of 1000 / 500 mtrs. +/- 5% tolerance OR Single length +/- 5% tolerance in case of quantity is less than 500 mtr.	

Plant & Yard Lighting

Sr. No.	Description
1.	Plant Lighting
a.	LP – WP Well Glass fitting suitable for 160W MLL / 200W GLS / 125W HPMV lamp in LM6 construction duly epoxy powder coating
b.	125W / 160 W HPMV lamp suitable for sr. no. 1
c.	2 Core X 1.5 mm ² Copper Armoured Cable
d.	3 Core X 1.5 mm ² Copper Flexible Cable
e.	Push Button Station WP, On-Off, in Die Cast Al. Alloy within built Cap
f.	Junction Box in Aluminium, TYPE : PFC

g.	Lighting Panel with switchgears
h.	Flameproof M.S. stopping plug Size
i.	Lighting DB & Distribution Box
j.	Number of Lamps – Suit to Layout
2.	Yard Lighting
	Street Light Fittings with Lamp HPMV 250 Watts Street Light Poles, GI Tubular Poles 8 – 11 Meter Length Lamp Pole – Lot.

Power Control Panel

Sr. No.	DESCRIPTION	SPECIFICATION
1	Type	Compartmental, Free Vertical Stand alone
2	Operation	Front Operated
3	Location	Inside Control Room
4	Cable Entry	From Top Detachable Gland Plates
5	ACB	Incomer ACB Should be with SC, OL & E/F Protection & Shunt Release. Other ACB's & MCCB with SC & OL Protection Only
6	Quantity	1 No.

6.6.11: TECHNICAL SPECIFICATIONS FOR WATER TREATMENT PLANT –

A] Filtration Plant - 50M³/hr

Duel Media Filter	
Operation Cycle	23 hrs.
Material of construction	Mild Steel with Epoxy Coating
Operating Pressure	3.5 Kg/cm ²
Pressure Vessel internally painted with black bituminous and externally with Red Oxide Primer	1 No.
Piping Work with Valves	1 No.

Graded filtering sand specially selected and graded	1 No.
Qty	One
Activated Carbon Filter	
Operation Cycle	23 hrs.
Material of construction	Mild Steel with Epoxy Coating
Operating Pressure	3.5 Kg/cm ²
Pressure Vessel internally painted with black bituminous and externally with Red Oxide Primer	1 No.
Piping Work with Valves	1 No.
Graded activated carbon specially selected and graded	1 No.

B] Softening Plant - 20M³/hr

Softener	
Maximum Working Pressure	3.5 Kg/cm ²
Minimum Working Pressure	2.0 Kg/cm ²
Pressure with Rubber lining from inside and externally with Red Oxide Primer	1 No.
Piping Work with Valves	1 Set.
Cation Exchange Resign	1 Set.
Hardness Test Kit	1 Set.
Brine Saturated Tank of MS Construction	1 No.
Brine Distribution System	1 Lot

C] DM Water Plant – 6M³/hr

Strong Acid Cation	1 No.
Degasser Tower & Pump	1 No.
Strong Acid Anion	1 No.

Mixed Bed Exchanger	1 No.
Qty	1 No.

6.6.12: Scope of supply for fire hydrant section

Sr. No.	DESCRIPTION	Nos.	Unit
	SECTION – A		
	FIRE HYDRANT SYSTEM COMPRISING OF PIPING,,FIRE HYDRANT VALVES , WATER GUM FOAM MONITOR & OTHER ACCESSORIES AS MENTIONED BELOW		
1.	Piping :	01	Lot
2.	Single Hydrant Valve :	01	Lot
3.	Double Door Hose Cabinet :	01	Lot
4.	Canvas Hose for Double door Hose cabinet:	01	Lot
5.	Hose Reel Drum with Fire Hose:	01	Lot
6.	Water Cum Foam Monitor:	01	Lot
7.	Single Hydrant Valve : (SHV) :	01	Lot
8.	Double Hydrant Valve : (DHV) :	01	Lot
9.	Canvas Hose for single door hose cabinet :	01	Lot
10.	Single Door Hose Cabinet:	01	Lot
	SECTION – B		
	SIAMESE INLET & BREACH CONNECTIONS		
11.	Breach Inlet connection	01	Lot
12.	Siamese Breaching Assembly	01	Lot
	SECTION – C		
	PUMP ROOM COMPONENTS :		
	FIRE PUMP AND ITS ACCESSORIES		
13.	Electric Driven Centrifugal Pump :	01	Lot
	Hydrant pump	01	Lot

	Jockey pump		
14.	Diesel Pump Suitable for Above - Kirloskar	01	Lot
15.	POWER CABLES - required for above pumps to control panel	01	Lot
16.	MCC Panel:	01	Lot
17.	Air Vessel :	01	Lot
18.	Non-Return Valve :	01	Lot
19.	Butterfly Valve:	01	Lot
20.	Accessories for Pump (Applicable only if it is negative Suction) :		
21.	Pressure Switch :	01	Lot
	SECTION – D		Lot
22.	FIRE EXTINGUISHER & BUCKETS		Lot
22.1	CO ₂ type Fire Extinguisher	01	
22.2	ABC Stored Pressure type Fire Extinguisher	01	Lot
22.3	ABC Stored Pressure type Fire Extinguisher 4 Kgs.	01	Lot
22.4	AFFF M Foam type Fire extinguishers	01	Lot
22.5	AFFF M Foam type Fire extinguishers	01	Lot
22.6	Fire Bucket with Support Stand (6 buckets –one stand)	01	Lot

6.6.13: SPECIFICATIONS FOR BOILER, TURBINE, PRDS, DG SET, STEAM PIPING

A. BOILER

Design code		IBR 1950 with latest amendments
Steam capacity	Kg/hr	18000
Steam pressure	Kg/cm ² (g)	45
Steam temperature	°C	490 ± 5
Feed Water Temp.	°C	105
Main fuel for boiler		Coal / rice Husk as supporting fuel or 100% Coal/Bagasse.

Concentration of solids	%	55-60	
GCV		Coal	Rice Husk
GCV	Kcal/kg	4000	3150
Fuel sizing		Free from mud & pebbles 100% < 25 x 25 mm, Fines Less than 1 mm Max. 10%	
Chimney		RCC	

B. STEAM PIPING

- High Pressure Steam from Boiler Header to Turbine Inlet.
- From Turbine Outlet to De-aerated tank in Boiler Section with required instrumentation.
- From Turbine Outlet to Common Point.
- From Outlet of PRV to common Point.
- From Common Point to respective sections header.
- Steam Condensate return from Distillation Section to De-aerated Tank in Boiler Section.

C. TURBINE

Description	Specification
Capacity	1500 KW
Type	Back Pressure
Inlet Steam Pressure	45 Kg/cm ² (g) ± 1
Inlet Steam Temperature	425 ⁰ C ± 5 ⁰ C
Outlet Steam Pressure	4.5 Kg/cm ² (g) ± 1
Outlet Steam Temperature	420 ⁰ C ± 5 ⁰ C
Quantity	1 No.

D. PRESSURE REDUCING AND DESUPERHEATING STATION

Equipment Name	Pressure Reducing Station followed by De-superheating Station [both are separate units, i.e., PRV + De-super heater]
Application	For Liquefaction & Dryer
Quantity	PRV – 1 No. De-superheating station – 1 No.

1.	Medium	Steam
2.	PRV	
	Inlet pressure	45 kg/cm ² (g)
	Inlet Temperature	440 °C ± 5°C
	Outlet Pressure	4.5 kg/cm ² (g)
	Outlet Temperature	420 °C ± 5°C
3.	DESUPERHEATING	
	Inlet Pressure	4.5 kg/cm ² (g)
	Inlet Temperature	420 °C ± 5°C
	Outlet Pressure	4.5 kg/cm ² (g)
	Outlet Temperature	151 ±5°C
4.	Water Temperature Available	30°C

Equipment Name		De-superheating Station
Quantity		De-superheating station – 1 no.
Application		For Turbine Exhaust
1.	Medium	Steam
2.	Inlet Pressure to De-super heater	4.5 kg/cm ² (g)
3.	Inlet Temperature to DS	220 °C ± 5°C
4.	Outlet Temperature from De-Super heater	151 ± °C
5.	Water Temperature Available	30°C

E. DG SET

Supply of suitable capacity SILENT Diesel Generating Set Confirming to New CPCB norms comprising of:- Radiator cooled Diesel Engine @ 1500RPM coupled to alternator of 415V 50Hz; 0.8 P.F. Mounted on sturdy M. S. fabricated base Frame, fuel tank, battery with leads, ant vibration mounting pads, safety Switches for LLOP, HWT, SRCP
 Quantity - 2 Nos.

6.6.14 Insulation & Cladding

a) **Insulation:** Insulation for Distillation columns, Reboiler & piping like Steam Chest, Hot Pipelines etc.

Material – Mineral Wool / Rock Wool

Density – 100 Kg/m³

b) **Cladding:** Aluminium Cladding of 24G

c) **Painting:** Painting as per requirement & relevant code to MS equipments & piping.

d) **Insulation of piping:**

Pipe insulation more than 50 mm shall be installed in multiple layers with joints staggered around the circumference.

All fittings including valves and flanges shall be insulated. Provide clearance for removal of flange bolts. After insulating valves or other piping specialty, wrap flange with Aluminium sheet and insulate the joint.

6.7: BATTERY LIMITS

1. Feed

1.	Feed	At the inlet of Hopper in Silo Section
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2. Process

1.	Chemicals	Inlet of dosing tanks in respective section.
2.	Carbon Dioxide	Outlet flange of CO ₂ Scrubber in the Fermentation Section.
3.	Spent lees	At the inlet of collection pit in distillation section.
4.	ENA/ TA	Outlet flange of issue flow meter in receiver section.
5.	Fusel Oil	Outlet flange of F. O. tank in storage section.
6.	DDGS	At the outlet of Diverter Valve in DDGS Dryer Section.

3. Utility

1.	Raw water	At the inlet of raw water storage tank.
2.	Process, Soft, DM	WTP in the scope of supplier

3.	Steam	At the Inlet of Steam Chest At 3.5 Kg/cm ² (g) & 148 ⁰ C in Distillation Section. At inlet of Jet Cooker at 3.5 Kg/cm ² (g) & superheated Temperature in Liquefaction. At inlet of rotary joint at 3.5 Kg/cm ² (g) & superheated Temperature in Dryer Section.
4.	Electricity	At the inlet of individual Incomer on MCC Panel in MCC
5.	Steam condensate	It is to be carried away by supplier up to the sugar mill condensate storage tank
6.	Vent & Drain	Vent & drain will be left by supplier at a minimum distance 30 meter from the final outlet.

6.8: MAKES FOR VARIOUS BOUGHT OUT ITEMS

Sr. No.	Name of Item	Make
1.	Plate heat exchanger	Alfa- Laval / GEA / Tranter
2.	Grain Silo	Krishna (GSI) / Fowler Westrup / Shirke
3.	Hammer Mill	Imported - Bliss Indigenous - Lark / R.K. Machines / Equivalent
4.	Centrifugal Pumps	Microfinish / Jhonson (SPX) /Kirloskar /KSB / CPV
5.	Motor	Crompton Greaves / Siemens /ABB/Bharat Bijali
6.	Valves (Ball/Butterfly/Gate/Globe)	Inter Valve/ Audco / Crane / Experts
7.	Control valve	Samson / Pneucon / Dembla
8.	Cooling tower	M-Square / Canara / Equivalent
9.	Decanter	Alfa Laval / Hiller
10.	Dosing pumps	Grosvenor / Positive / Metering / Precidose
11.	Agitator	Mojj
12.	Screw feeder	Mojj
13.	Air blower / Vacuum pump	PPI / TMVT

14.	Gear boxes	Radicon / Greaves /Elecon
15.	Weighing System	Nova /Avery India
16.	Jet Cooker	Hydro Thermal
17.	Weigh Bridge	Mettler Tolledo / Nova Weigh / Essae
18.	Air Compressor	Ingresoll Rand / Atlas Copco/ Chicago Pneumatic
19.	Air Filter	Dyna / Equivalent
20.	Rota meter	Eureka / Fedicon Device
21.	Temperature sensor	Eureka/ Radix / Pyro / GIC
22.	Pressure gauge/temperature gauges	H. Guru / Wika / GIC / Pioneer / Waaree
23.	Pressure, Temperature / Level / Flow transmitter	Emerson / ABB / Yokogava / E & H
24.	Flow Meter (Digital)	Rockwin / Toshniwal / Forbes
25.	PLC	ABB /Allen-Bradley / Siemens
26.	PC with monitor printer	Compaq / HP / IBM / Dell
27.	Variable Freq. Drive	ABB / Siemens
28.	Electric cables	Finolex/ CCI /Incab / Polycab
29.	Instrument Cable	Poly cab / Gemscab
30.	Starter	Schneider / Siemens / L & T
31.	Actuator	Inter valve/ Crane / Delaval
32.	Switch Fuse Unit	Siemens / Telemehaniqe / L&T
33.	Lighting Material (Flameproof)	Phillips / Crompton Greaves / Bajaj / Wipro
34.	PVC Wire	Polycab / Finolex / RR
35.	MCCB / ELCB / RCBO / MCB	L & T / Siemens / Legrand
36.	Power Contactors	L & T / Siemens

37.	Plug & Sockets	L & T / Siemens / Legrand
38.	Digital Meters	Conserv / L & T / Phasetrack / HPL
39.	Indicating Lamp	Tecnic / Atlos / Siemens
40.	Push Buttons	L & T/Siemens/Teknic
41.	Cable Gland	Comet / Dowell / HMI
42.	Diesel Pump	Kirloskar
43.	Lugs	Dowell / Jaison
44.	PVC Conduit	Dimond / Modi / Precision / Equivalent
45.	Selector Switch	Kaycee / L & T / Siemens
46.	Foam Sensor / Level Switches	SBEM / Pune Tech
47.	Actuator Butterfly Valve	Crane
48.	Orifice Plate	Star-Mech / Eureka
49.	UPS	Emerson / Pneumeric Power / Novetur
50.	Air Conditioner	LG / Videocon / Blue Star
51.	D. O. Copper	Allcobax / Multimetal / Rachna Metal Industries (P) Ltd.
52.	S.S. Plate and Sheets	SAIL / Jindal / Acerinox / Outokumpu
53.	MS Plate and Sheets	SAIL / Jindal / Tata / Esser / Arcellor Mittal
54.	SS tubes	Bhandari Foils & Tubes (P) Ltd. / Prakash Steelage Ltd. / Shubhalaxmi Metal & Tubes (P) Ltd./Salasar Stainless Ltd.
55.	GI nut & bolts	Standard
56.	M. S. Structural Material (Channels, beams, angles)	TATA / SAIL/Jindal
57.	HDPE Pipes	Hasti / NOCIL
58.	Carbon steel pipes	TATA/ Jindal / Zenith

CHAPTER – VII: TREATMENT OF EFFLUENT

The mother liquor left behind after distilling-off alcohol is called as stillage. The stillage of distillery poses a very serious problem by way of threat to the environment.

The VSSSKL management has decided to install new 45 KLPD grain based distillery plant to produce R.S. or ENA. Sugar mill management has also decided to install Decantation section, Multiple Effect Evaporation section, Mingler section to produce Distiller's Wet Grains with Solubles (DWGS), Steam Tube Dryer to produce Distiller's Dried Grains with Solubles (DDGS) and standalone multiple effect spentwash evaporation plant as primary effluent treatment system followed by Up-flow Anaerobic Sludge Blanket (UASB) digester for treatment of process condensates, CIP effluents, Boiler & Cooling tower blow downs, Fermenter washing water etc. In UASB digester COD & BOD % values are reduced and biogas produced, which is used as a fuel in boiler.

The effluent coming out of the UASB digester is further treated in the polishing aerobic reactor to bring down the BOD as per the norms of pollution control authorities and then can be used for ferti-irrigation purpose.

Decantation section: The alcohol stripped whole stillage or spent mash or thick stillage coming out of distillation section is subjected to decantation by centrifugation to separate the suspended fibrous mass called wet cake and thin stillage. Wet cake has about 30 % w/w total solids as removed from the bottom of the decanter and can be directly loaded on the trolleys. Wet cake can be used directly in the formulation of animal feed. Otherwise, wet cake is taken to the mingler for further processing.

Composition of Wet cake and thin slops are given in Table 7.1 and 2.2, respectively.

Table 7.1: Composition of Grains & Wet cake (after decantation)

Sr. No	Contents	Sorghum		Rice / Broken rice	
		Grains	Wet cake	Grains	Wet cake
1	Total solids	87 - 91	28 - 32.0	88 - 90	28 - 30.0
2	Moisture	9 - 13	68 - 72	10 - 12	70 - 72
3	Starch	64 - 70	1.9 - 2.1	65 - 70	1.9 - 2.1
4	Proteins	7 - 11.0	7 - 11.0	4 - 7.0	4 - 7.0
5	Oils/Fats	2.2 - 3.2	2.2 - 3.2	0.4 - 1.0	0.4 - 1.0
6	Crude fibers	3.3 - 4.1	3.3 - 4.1	0.8 - 1.6	1.0 - 1.7
7	Inorganic ash	1.0 - 1.6	1.1 - 1.6	0.4 - 1.2	0.45 - 1.3

Table 7.2: Composition of Thin Slop

Sr. No.	Parameters	Values
1	Flow	200-300 M ³ /day (after decantation)
2	Total solids (T.S.)	9 - 10 % (W/W)
3	COD	50-60,000 Mg/Lit.
4	BOD	30 - 35,000 Mg/Lit.
5	T.S.S.	15,200 - 16,000 Mg/Lit. (Max.)
6	Temperature	38 - 40°C
7	pH	4.5 - 5.0

Table 7.3: Technical specification for stillage recycling system

Sr. No.	Description	Specification	MOC	Nos.
1.	Decanter	Horizontal Centrifugal	Contact parts-SS 316	1 + 1
2.	Raw Stillage tank	30M ³	MS with Epoxy paint	1 No.
3.	Thin Stillage tank	65M ³	MS with Epoxy paint	1 No.
4.	Conc. Stillage tank	10M ³	Contact parts SS	1 No.

			304, Non – contact pars in MS	
5.	Piping and valves	As per process Standard		1 lot
6.	Instrumentation & Control	As per process Standard		1 lot

Pumps & Motors:

Sr. No.	Pump	Type	MOC	Nos.
1.	Raw Stillage feed pump	Centrifugal	Contact part – SS-304	1 + 1
2.	Thin Stillage pump	Centrifugal	Contact part – SS-304	1 + 1
3.	Conc. Stillage Feed pump	Centrifugal	Contact part – SS-304	1 + 1

7.4: Technical specification for stillage evaporator

Evaporators are classified by the number of effects. In a single-effect evaporator, steam provides energy for vaporization and the vapor product is condensed and removed from the system. In a double-effect evaporator, the vapor product off the first effect is used to provide energy for a second vaporization unit. Triple- effect evaporator, the vapor product off the second effect is used to provide energy for a third vaporization unit. This cascading of effects can continue for many stages. For special applications, Multiple-effect evaporators consisting of even 12 effects have been designed. Multiple-effect evaporators can remove much larger amounts of solvent than is possible in a single effect.

In a multiple effect arrangement, the latent heat of the vapor product off of an effect is used to heat the following effect. Effects are thus numbered beginning with the one heated by steam. It will have the highest pressure. Vapor from Effect I will be used to heat Effect II, which consequently will operate at lower pressure. This continues through

the train: pressure drops through the sequence so that the hot vapor will travel from one effect to the next.

Normally, all effects in an evaporator will be physically the same in terms of size, construction, and heat transfer area. Unless thermal losses are significant, they will all have the same capacity as well.

Evaporator train may receive their feed in several different ways. The feed order is not related to the numbering of effects. Effects are always numbered according to decreasing pressure (steam flow).

Forward Feed arrangements follow the pattern I, II, III. These require a single feed pump (reduced fixed costs). They typically have reduced economy (higher operating costs) since the cold feed must be raised to the highest operating temperature. These also tend to have the most concentrated liquor, which tends to be the most viscous, in the lowest temperature effects, so there may be difficulties getting a good overall heat transfer coefficient.

Backward feed arrangements go III, II, I. These need multiple pumps to work against the pressure drop of the system; however, since the feed is gradually heated they usually have better economies. This arrangement also reduces the viscosity differences through the system and so is better for viscous solutions.

Table 7.4.1: Technical specifications for Multiple Effect stillage Evaporation plant

Sr. No.	Description	Nos.	Technical Data	M.O.C
1.	Multiple Effect Evaporators	4	Type : Shell & Tube Falling Film & Forced Circulation For FFE - Tube 50.8 mm OD & 1.2 mm thk For FC - Tube 38.1 mm OD & 1.2 mm thk.	Contact parts – SS-304
2.	Vapour Separators	4	Suitable	Contact parts –

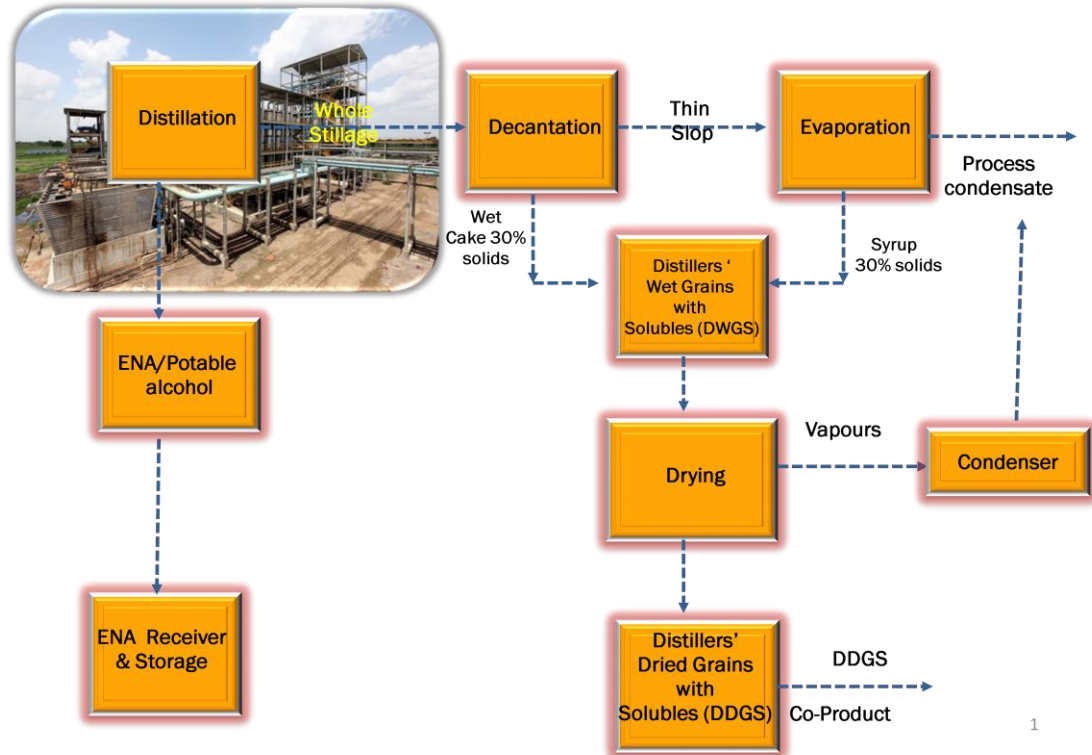
				SS-304
3.	Surface Condenser	1	Type : Shell & Tube Tube 38.1 mm OD & 1.2 mm thk	Contact parts – SS-304
4.	Piping and Valves	Lot	As per process Standard.	
5.	Instrumentation & Control	Lot	As per process Standard.	

Pumps & Motors

Sr. No.	Pump	Type	Shaft Seal	MOC	Nos.
1.	Circulation pumps	Centrifugal	Single Mech.	Contact part – SS-304	4 + 4
2.	Alcohol condensate transfer pumps	Centrifugal	Single Mech.	Contact parts – SS-304	1 + 1
3.	Process Condensate Pump	Centrifugal	Single Mech.	Contact parts – SS-304	1 + 1
4.	Conc. Spent Wash Transfer Pump	Centrifugal	Double Mech.	Contact parts – SS-304	1 + 1
5.	Vacuum Pump	-----	----	Contact parts – SS-304	1 + 1

Mingler/Mixer section: The concentrated syrup from the evaporation section at 28-30 % w/w total solids and wet cake coming from the decanter bottom at 30 –32 % w/w total solids is further mixed thoroughly in an agitated mingler to produce DWGS containing 30 % w/w total solids.

EFFLUENT TREATMENT PLANT BLOCK DIAGRAM



1

DRYER SECTION: DWGS is subjected to further drying in the dryer system to produce DDGS. This also requires additional steam.

The steam tube dryer system operation consists of the following two stages.

FEED CONDITIONING AND DRYING

1. Feed Conditioning:-

The wet material is sticky in nature and will result in coating of tubes if fed as such. To temper this sticky character, the feed of wet DDGS is mixed with part of the dry product. The resultant mixture is not sticky and can be handled in tubular dryer. The wet material is dozed and mixed with part of the dry product in a suitable paddle mixer. The properly mixed feed is fed to dryer.

DRYING:-

In the steam tube dryer, the wet feed is continuously agitated and heated by means of a rotating shell type tubular dryer with steam heated tubes. The material gets dried during its passage across the dryer. The dried material is continuously discharged via the

main rotary valve. Part of the dried material (quantity is controlled by the diverter rotary valve) is sent to the paddle mixer via back mixing conveyor. The moisture which is evaporated during the drying operation is exhausted via an ID fan. The hot air (which is generated in a finned tube heat exchanger, heated by steam) is used as a carrier gas for exhausting the vapours.

The final moisture content of DDGS is about 8.0 to 9.0 %. The quantity of DDGS produced is around 250 to 260 kg per MT of corn or sorghum processed. We have considered production of DDGS of about 28 – 30 MT/day. DDGS specifications are given in the following table 7.5.

Table 7.5: DDGS Specifications

Sr. No.	Description	Quantity/Percentage
1.	DDGS final product	250-260 kg/MT of grains
2.	Moisture	10 %, w/w
3.	Dry matter solids	90 %, w/w
4.	Proteins	36.38 % ,w/w
5.	Fats & oils	6-8 %, w/w
6.	Inorganic ash	3-5 %, w/w
7.	Other organics	39-43 %, w/w

The advantage of DDGS manufacture in the grain based distillery is that there is no effluent (liquid or solid) produced in the plant. Thus, the integrated grain distillery with DDGS system becomes zero effluent discharge plant.

Table 7.6: Technical specification for rotary tube bundle dryer

Shell & Tube Assembly	
The rotary shell of the dryer is Mild Steel construction with SS304 inside cladding. Sufficient No. of tubes in SS304 are fitted on the outer regions of the tube sheets. The outer periphery of the shell serves to mount on tire assemblies and a girth gear for support and location and rotation of the dryer.	
Shell Material of construction	Mild steel with inside SS-304 cladding
Tube Material of construction	SS 304, ERW

Nos.	1 No
Drive Arrangement	
Drive motor rotates the dryer through a drive train of pulleys, V belts, gearbox, flexible coupling and pinion / girth gear assembly. All drive components are mounted on a common M.S. base frame.	
Feed Section	
Wet cake & concentrated Stillage from Grain plant mixed in a Feed conditioner followed by screw conveyor which is fed in dryer through a stationary cover located at a central cut-out on the tube sheet.	
Vapour Exhaust	
On the stationary COVER on the discharge side, there is an exhaust port which is to be connected to cyclone separator in SS304 contact parts with Rotary air lock & exhaust fan for exhaust of vapors to atmosphere. MOC of ducting SS 304 Contact parts.	
Vapour Blower	
A centrifugal blower driven by a TEFC motor through V belt and pulleys is provided. The blower is statically dynamically balanced.	
Type	Centrifugal
Drive	Belt Driven
Material of Construction	Impeller : SS-304 Casing : SS-304
Post Drying	
The Product from Rotary Dryer is fed to Post Drying System to achieve 10% - 12% w/w moisture Content in DDGS. The Material of Constriction SS-304 for Contact Parts. Non-Contact Parts are in Mild Steel.	
Product Discharge	
At the end of the rotary shell, near the steam supply end, there are ports for discharge of the feed into a fixed receiver. Product is collected from the bottom of the receiver, at an elevation from finished floor level. This product from rotary dryer will be fed to post drying section thru a screw conveyor in carbon steel. The final product from post drying section will be collect from discharge Rotary valve below twin cyclone separator in carbon steel. Material of Construction – Mild Steel	

Discharge Screw & Bucket Elevator	
Product from rotary dryer feed to post drying section through screw conveyor followed by bucket elevator. Material of Construction – Mild Steel.	
Non Condensable	
Non condensable in steam are vented to atmosphere through suitable vents, valves, from the steam manifold.	
Access	
The cut-out is large enough for partial manual access into the dryer for cleaning and maintenance as and when required.	
Cyclone Separator	
High efficiency twin cyclone separator is provided for separating the product from exhaust air and exhaust vapours. The product is discharged through a discharge Rotary valve at the bottom of the cyclone.	
Type	Tangential Entry
Material of Construction	Mild Steel for Product
Support Bracket	Carbon Steel
Accessories	Inspection / cleaning hand hole, support bracket, Vortex breaker, Discharge Valve, U-tube manometer.
Rotary Air Lock Valves (construction) –	
A motorized rotary air lock valve is fitted to discharge the dry powder through the chute.	
Material of Construction	
Housing	Aluminium
Rotor	Carbon Steel
Ducting from Post Dryer to collection cyclone in Mild Steel. Vapour ducting from rotary dryer to vapour cyclone in SS-304	

7.7: Technical specification for Secondary effluent treatment plant

1. Equalization tank – One No
RCC equalization tank of Suitable capacity shall be provided to collect vapour condensate from evaporator and spent-tees from distillation.
2. pH Dosing tank – One No
One no pH dosing tank of suitable capacity shall be provided.
3. pH Dosing pumps – Two No (1W+1SB)
Two no pH dosing pump of suitable capacity shall be provided.
4. Effluent lifting pumps – Two No (1W+1SB)
Two no condensate lifting pump of suitable capacity and suitable head shall be provided.
5. Bio Tower – One No
One no RCC reactor of Suitable capacity shall be provided. Bio-tower and trickling filters are relatively simple treatment units with full of media over which the process flow is distributed, or “trickled.” The media is used as a surface on which to grow a biological mass which will contain and support a population of microorganisms which perform the actual treatment that takes place in the Bio-tower and trickling filters.
6. Aeration tank – One No
The partially treated effluent from Bio tower shall then be subject to activated sludge process for further reduction of organic matter. Aeration tanks are provided for degradation of organic matter through biological process. Microorganism in the controlled environment carries out the biodegradation process.



7. Blower – I – Two Nos.

Two no blowers (1 Working + 1 Standby) of suitable capacity shall be provided to facilitate aeration in aeration tank-I.

8. Treated Water Sump- One No.

One no RCC pre-treated water sump of suitable capacity shall be provided to collect the treated water.

9. Treated Water transfer pump – Two No (1w+1SB)

Two no filter feed pump of suitable capacity shall be provided to feed multigrade filter.

10. Multi-grade Filter – One No

One No suitable capacity multi-grade filter shall be provided to remove suspended solids in treated water. Its internals shall be fabricated of carbon steel.

11. Activated Carbon Filter – One No

One no suitable capacity activated carbon filter shall be provided to adsorb the impurities from treated water. Its internals shall be fabricated of carbon steel.

7.8: Technical specifications membrane treatment plant

Micron Filtration System - 1 Set.

Max. Working Pressure : 3.5 kg /cm²

M.O.C. Of Housing : FRP

MEMBRANE – 1No.

High Pressure pump : Vertical Multistage SS Pump

Quantity : 1nos.

Pressure tube : FRP

Skid : MS Coated with Powder paint

C.I.P. System with SS Pump

CHAPTER –VIII: PERSONNEL REQUIREMENT

VSSSKL is having existing molasses based 60 KLPD Distillery plant based on Continuous fermentation and MPR distillation system. To exploit more benefit from this industrial complex, the management of the sugar mill has decided to install new 45 KLPD grain based distillery plant, stillage evaporation plant and secondary effluent treatment system to achieve “Zero Liquid Discharge” (ZLD) as per CPCB/MPCB norms. The management of VSSSKL has also decided to install 18 MT/hr @ 45 Kg/cm² pressure boiler and 1.5 MW TG set for 45 KLPD grain based distillery plant.

VSSSKL distillery plant is under Administrative Control of Managing Director of the sugar mill and they have already appointed Distillery Manager, Distillery Chemists, Lab. Chemists, and Operators for fermentation and distillation section, other skilled and unskilled workers for their existing 60 KLPD distillery plant.

Existing distillery staff will not be able to operate the new 45 KLPD grain based distillery plant and effluent treatment systems. Therefore, there is requirement to appoint additional staff for distillery plant and effluent treatment systems as well as operation.

The section wise requirement of staff and workers and their estimated salary and wages are given in the following table.

Additional staff salary and wages-

A) For 45 KLPD Grain based distillery plant staff salary and wages-

Sr. No.	Designation	No. of Posts	Total Annual Salary (Rs. Lac)
1.	Distillery Sr. Chemist	01	4.00
2.	Distillery Chemist	03	10.00
3.	Assistant Engineer (Elect./Mech.)	01	3.00
4.	Lab. Chemist	3+1	9.60
5.	Milling plant-Operator	04	10.66
6.	Liquefaction plant-Attendant	03	6.00
7.	Fermentation process attendant	03	6.00

8.	Distillation plant - Operator	04	10.67
9.	Distillation process attendant	03	6.00
10.	Evaporation plant operator	04	10.67
11.	Evaporation plant attendant	03	6.00
12.	DDGS and Decantation plant operator	03	6.00
13.	Decantation plant attendant	03	8.00
14.	DDGS plant attendant	03	6.00
15.	Ware house Attendant	02	4.00
16.	Pump Attendant	03	6.00
17.	Laboratory Attendant	02	4.00
18.	Peon	01	2.00
19.	Helper	04	6.00
	Total (A)	46	124.60

B) For Condensate Polishing Unit (CPU) -

Sr. No.	Designation	No. of Posts	Total Annual Salary (Rs. Lac)
1	Plant Operators	03	8.00
2	Helper	02	3.00
	Total (B)	05	11.00

C) For Boiler section -

Sr. No.	Designation	No. of Posts	Total Annual Salary (Rs. Lac)
1	Maintenance Engineer	04	14.40
2	Senior DCS Operator	03	9.00
3	Assistant DCS Operator	04	9.60
4	Worker	12	10.08
	Total (C)	23	43.08

D) For Turbine section –

Sr. No.	Designation	No. of Posts	Total Annual Salary (Rs. Lac)
1	Turbine attendant	03	5.40
2	Assistant turbine attendant	04	4.80
3	Worker	04	3.36
	Total (D)	11	13.56

Total (A+B+C+D)	(Rs. Lac)	192.24
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CONCLUSIONS AND RECOMMENDATIONS

1. The feasibility report is prepared based on information provided by VSSSKL to the Institute.
2. The new 45 KLPD grain based distillery plant is to be based on latest technology to produce Rectified Spirit or Extra Neutral Alcohol.
3. The total requirement of grain is 34,085 MT for proposed 45 KLPD grain based distillery plant considering working for 300 days per annum (100% capacity utilization). The VSSSKL will purchase grain quantity 34,085 MT from nearby market.
4. The total investment for 45 KLPD grain based distillery plant based on multipressure distillation technology, Stillage evaporation, DDGS dryer, Secondary effluent treatment system, boiler (steam production capacity 18MT/hr, steam pressure @45 Kg/cm²), T.G. set (1.50 MW/hr), civil & structural works including taxes and duties shall be Rs. 6,532.82 Lacs.
5. Special arrangement for water treatment should be undertaken depending on raw water quality.
6. The technical specifications included in this feasibility report are based on information supplied by Plant supplier's to the sugar mill. Institute has updated it from time to time. However, it will be guideline and may change/improve further depending on quality.
7. Some of the inputs and utilities are available with the sugar mill. It needs to be discussed thoroughly at the time of inviting and technical discussion before negotiation and finalization of order.
8. It is recommended to operate the distillery throughout the year (300 days/annum). For this purpose special boiler (18 MT/hr, 45 Kg/cm² g) and new T.G. set (1.50 MW) has been recommended for meeting the requirement of steam and power and to achieve "Zero Liquid Discharge" of stillage.
9. As regards effluent treatment; modern method of decantation followed by evaporation and followed by dryer will result in total conversion of stillage in to animal feed (either as DWGS or DDGS). For other effluents such as process

condensate, spentlees, boiler / cooling tower blow down water, vacuum pump/pump gland cooling water etc. a secondary effluent treatment system is required so as to achieve “ZLD” as per CPCB norms.

10. Based on the performance of the proposed distillery plant, mentioned in earlier chapters, financial parameters are computed which are mentioned below:-

Capacity Utilization of Distillery plant	100 %
Internal Rate of Return (IRR)	13.73 %
Break Even Point (BEP)	76.58 %
Payback period	4 years
Debt Service Coverage Ratio (DSCR)	
Average	1.65
Maximum	2.09
Minimum	1.25

11. The earlier discussions on technical configurations and financial parameters in foregoing chapters reveal that this project is technically feasible and financially viable. The financial projection indicates higher percentage of profits, sufficient cash generations to repay the loan with interest. All the financial parameters normally considered for financing the project are quite favorable. We conclude that the proposal in the present form is technically feasible, financially viable and so can be considered favorably for financing.

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MULTIPLE EFFECT EVAPORATION PLANT SUPPLIERS

- * S. S. Techno Services Pvt. Limited,
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