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Utility Saving Opportunities in a Solvent Extraction Process

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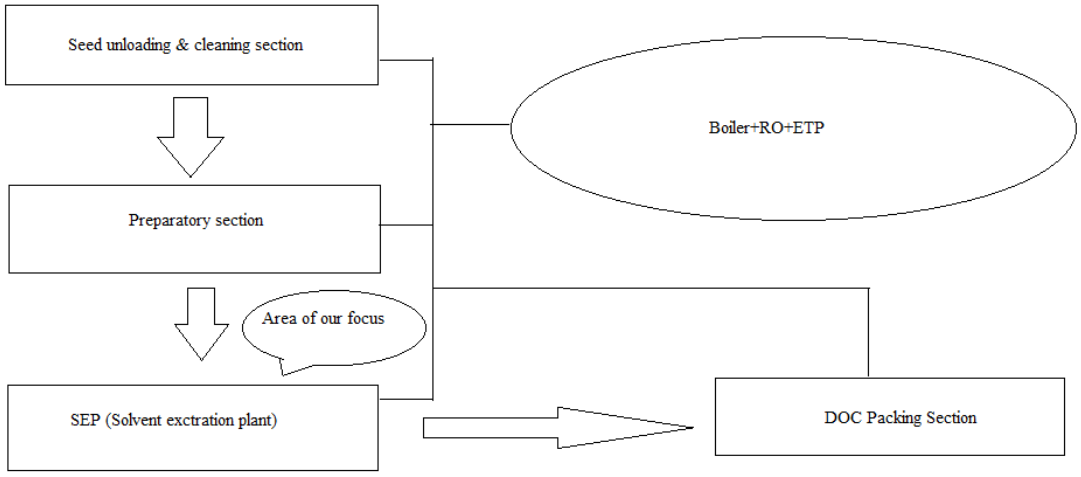
Abstract

Solvent Extraction Process is the combination of many deferent activities. In such industry it is used to extract the oil from soya Seed. This report made on the process adopted and equipments installed at 1000 TPH soybean crushing unit. The objective of this paper is to introduce the Production with energy efficient techniques by minimization of losses in the extraction process and Safety Processes along with Hazardous Critical Control Points .

Introduction:-

The complete Solvent Extraction Process has the following sub sections:-

- 2 no. of Seed unloading and cleaning section.
- 1 no. of process silo having storage capacity of 600 MT.
- 1 no. of preparatory section having 3 no. of Crackers, 2 no. of cookers,
- 6 no. of flakers and 2 no. of Expander.
- 1 no. of DOC cooling and packing section.
- 1 no. R. O. Plant having capacity of 25 M^3/H treated water.
- 2 no. of Boilers having capacity of 10 MT/H (each) Steam generation.
- ETP having capacity of 400 M^3/D.
- Electrical Power Sub-station with HT Line 1600 KVA and 1 no. of D.G. Set 1010 KVA



In this plant our area of interest is the solvent extraction process SEP which is shown in the above fig.

Methodology:-

The study was carried out to examine the oil extraction process with minimum losses and safety precousions and following observations has been taken

The unit has 1000 TPD Solvent Extraction Plant. The flakes/collets are transferred to the SEP through a reddler conveyor. In SEP, there are three major processes involved:

i. **Solvent Extraction**
ii. **Disolventisation & Toasting (DT)**
iii. **Distillation**

i. Solvent Extraction

The pallets / flakes are fed through rotary valve into the extractor (size: 25 X 2.5X 5 mtr). The rotary valve is sealed with flakes/ pallets to avoid leakage of hexane vapor of extractor. Pallets are fed at the rate of 1000 MT/day. The hexane spray (in circulation) is maintained. The output from the extraction is Miscella (mixture of oil and hexane) and Wet De-oiled cake (DOC). The concentration of oil in the Miscella is 25-35%. The hexane concentration in the Wet DOC is 25-30%. Temperature of re-circulated miscella in the extractor is maintained at 55 –58^{O}C. The Miscella is sent for further processing like distillation, solvent recovery where as wet DOC or de-oiled meal is directly fed into De-solventiser & Toaster(DT).

ii. Disolventisation & Toasting (DT)

The objective of this process is to recover the hexane present in the DOC and to reduce the ureas activity. The sizes of DT is 4 X 8 mtr. This is a vertical vessel containing 7 no. of compartments in which wet DOC, containing 25-30% hexane is fed. In order to remove hexane, direct as well as indirect steam is used. Indirect steam

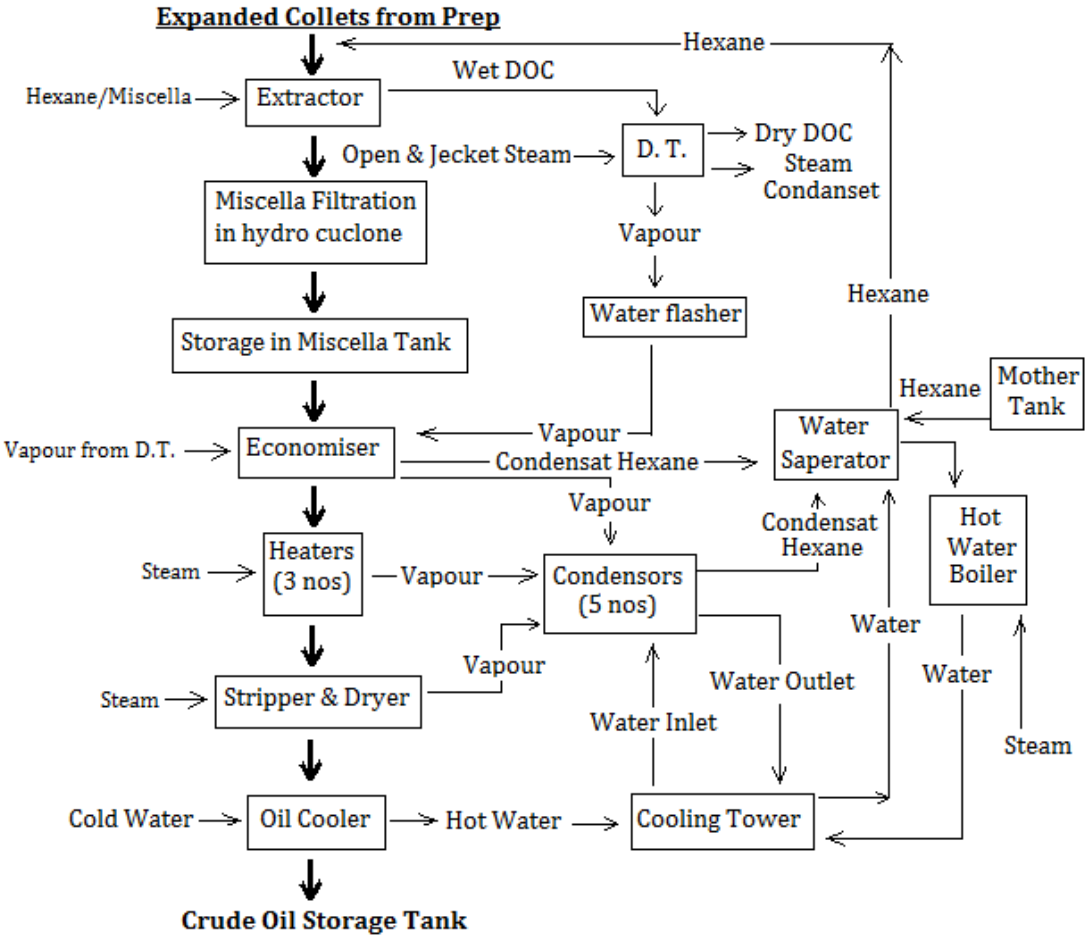
is used for raising the temperature while direct steam is used for absorption. Out of 7 compartments, two compartments from the top are for de-solventization; subsequently below five compartments are for toasting. The temperature maintained in the 1st and 2nd compartment of the De-solventiser is around 80^{O}C and respectively it increase up to 105^{0} C. The condensed steam water received from D.T. is sent to the boiler feed tank through a auto condense pump. And the hot hexane vapor containing steam is passed to preheat the Miscella before its evaporation through a water flasher. Where the condensed hexane from economizers is collected in hexane-water separator, where hexane is recovered and water is passed to hot water boiler. The uncondensed hexane vapor is passed to the condenser and re-used in process after collection in liquid form.

iii. Distillation

The purpose of Distillation is to separate hexane from Miscella. The Miscella is passed through economizer for pre-heating and to increase the concentration of oil up to 75%. The oil concentrated Miscella is further processed in evaporator (Heater) to increase the oil concentration up to 99%. In the economizer temperature of Miscella is raised up to 60–65^{O}C. The economizer is maintained at 350–400 mmHg vacuums. In the Heaters temperature of Miscella is increased up to 95–100^{O}C. The evaporated hexane vapor from economizer and Heaters are condensed in the condenser (5 Nos) and separated in the water solvent separator. The recovered hexane is further sent for circulation. The traces of hexane present in the oil after evaporator is removed in stripper-cum-dryer where the temperature maintained at 110-115^{O}C and vacuum about 700 mmHg and oil concentration in Dryer increased up to 100%. Final Crude oil is stored in crude oil storage tanks.During solvent extraction process, the average hexane loss lies between 1.5-2 Ltr/T of seed processed. The losses of hexane occurs in the following areas:

- Traces in crude oil
- Traces in final DOC
- Through final vent
- Through hot water
- Through leakage
- During plant Start-up & Shut Down.

The desired process parameter solvent extraction Plant and the Process Flow Diagram (showing various inputs, outputs & waste) of Solvent Extraction Plant is given **Below……**



Data Analysis, Implementation and Result:-

The study is based on primary data collected from the Solvent Extraction Process..

S. NO.	Item Name	Particular	Actual Running	Permissible Range Should be	Role on efficiency
1	Extractor	Material Inlet Moisture	11-13.5%	9 – 9.5%	It can cause the extra load on the entire extraction process and consume more heat to evaporate the water vapour
		Material Inlet Temperature	60-62 ^{0}C	50 ^{o}C - 55 ^{o}C	Very high and very low inlet temperature will result in the decrease in the extraction efficiency of the extractor and cause the loss in the form of hexane

		Spray Temperature	55-65 ^{0}C	53 ^{o}C - 58 ^{o}C	High temperature of spray will result more Hexane loss in the extraction and also it may cause the vapor lock in the condenser inlet lines
		Rich Miscella	32-35%	25% - 28%	Very rich miscella leads to increase the tendency of mixing of oil with the hexane and it is consumes more time and heat to separate them.
2	Economizer	Miscella	60-70%	60% - 75%	Miscella concentration in the economizer should be in the feasible range because fluctuation may disturb the entire distillation process and consume more heat and less hexane recovery.
		Vacuum	250-300mm	300– 350 mm	Adequate vaccum is necessary for proper recovery of hexane
3	Heater	Temperature	100-150	100 ^{o}C-110 ^{o}C	Very high temperature is not required in heater it may cause the back pressure in the condenser
		Vacuum	300-350mm	350 – 450 mm	It should be within the given range for better recovery
4	Stripper-cum-Dryer	Temperature	150-200 ^{o}C	100 – 120 ^{o}C	Very high temperature here also cause the back pressure in the system
		Vacuum	550-600 mm	500 – 700 mm	It should be within the given range less vaccum cannot extract the all vapor from the distillation unite
5	Crude Oil	MIV	0.15-0.25%	0.15- 0.25%	Not affect the performance
		Flash Point	100 ^{o}C	120 ^{o}C	Low flash point results the loss of hexane along with the oil
		Color	42-45 Unit	35–38 Unit	More color means more loss of oil and hexane

					both because it is the measure of the separation of oil and hexane.
6	DT	Outlet Vapor Temperature	65-100 ^{o}C	75– 80 ^{o}C	Too high and too low temperature cannot economical to recover the hexane vapour from DT
		D. T. Temperature	75-110 ^{o}C	90– 105 ^{o}C	Too high and too low temperature cannot economical to recover the hexane vapour from DT
		D. T. Vacuum	05-10 mmwc	10-15 mm wc	Permissible range is necessary for proper hexane recovery
		Oil	0.9-1.0%	Below 0.89%	Loss of oil with DOC
		Flame Test	Exist light	Nil	Existence indicates the loss of solvent

Conclusions:-

In this section there is lot of energy conservation opportunities such as steam, water, power and Hexane consumption is more than enough in this plant which can be eliminated. There are many pumps are installed in the distillation section without any specific function and they can be modified. There is the need to installation of V.F.D. for some major pumps and at the extractor drive to reduce power and hexane consumption. Some modification in the pipelines of condenser water and cooling tower water may help to reduce water consumption.somemodifications in steam distribution may help to reduce steam consumption such as the use of P.R.V. and R.T.D.in heaters with PLC Control. Besides of them some suggested points for extraction process which can be useful for energy saving and also important for safety point of view are;-

- Automatic starting and stopping of the extractor according to the level of material in the feed hopper. Extractor feed Hopper must always be filled with sufficient material so as to form a barrier between the feeding conveyor and the extractor.
- Alarm system to indicate the low level of extractor hopper and Automatic stopping of the raw material feed in case of abnormally high level in the feed hopper.
- Electric interlocking of all solid material handling equipment, such as elevators, screws, conveyors, extractor, D.T., rotary valves etc…
- The “speed sensor” device or “speed alarm switch” for any motor of the material handling equipment, in case of accidental stopping due to shear pin breaking or hydro coupler slipping of any equipment.
- Shutting of main steam valve in case of power failure.

- Automatic stopping of D.T. feed when steam pressure fails below the normal operating pressure.
- Alarm if D.T. is not fed with material for a certain period and the heating steam pressure in the toaster has not been reduced.
- Alarm if the cooling water pressure drops.
- Alarm if the compressed air and instrument air pressure drops.
- Alarm if the high temperature in the six compartment of D.T.