PRODUCTION PROCESS IN MODERN GRAIN BASED DISTILLERIES

PRESENTED

BY

DR. SEEMA PAROHA
# GRAIN COMPOSITION

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Solids</td>
<td>87-91</td>
<td>88-92</td>
<td>88-90</td>
<td>88-92</td>
</tr>
<tr>
<td>Moisture</td>
<td>10.13</td>
<td>8-12</td>
<td>10-12</td>
<td>8-12</td>
</tr>
<tr>
<td>Proteins</td>
<td>9-10</td>
<td>7-11</td>
<td>4-7</td>
<td>11-13</td>
</tr>
<tr>
<td>Fats/Oils</td>
<td>2.2 - 3.2</td>
<td>3.5-5.0</td>
<td>0.4-1.0</td>
<td>1.5-2.0</td>
</tr>
<tr>
<td>Crude Fiber</td>
<td>1.8/-2.5</td>
<td>1.5-2.0</td>
<td>0.3-1.0</td>
<td>2.0-3.0</td>
</tr>
<tr>
<td>Inorganic Ash</td>
<td>1.2-2.0</td>
<td>1.0-1.5</td>
<td>0.5-1.6</td>
<td>1.5-2.5</td>
</tr>
<tr>
<td>Other Organics</td>
<td>10-14</td>
<td>7-9</td>
<td>4-10</td>
<td>7-10</td>
</tr>
</tbody>
</table>
PRE CLEANING AND STORAGE

• Grain received in the factory contains foreign material like dust, straw, stem residues and jute. It is very important to clean the grain prior to storage and consumption in process.

• STORAGE – Grain is stored in silo made up of galvanized iron. Silo is equipped with blowers for aeration and sweep auger for unloading from silo.

• PRE CLEANER- It is a set of vibrating screens having different size of sieves for separation of different foreign particles and heavy dust cleaner is attached with a centrifugal fan to create mild vacuum for separation of light weight dust.
• **DE STONNER** - For separation of stone particles. Made up of a inclined vibrating screen with vacuum.

• **MAGNETIC SEPARATOR** – There are two types of magnetic separator in practice, one is rotary magnet drum type and other one is grating type. The iron particles present in the grain being separated while it is passing through magnetic separator.
PRE CLEANER
DESTONER
STORAGE SILO
MILLING

• HAMMER MILL

• ROLLER MILL

• PARTICLE SIZE – The optimum particle size of flour required as below
  Over size - > 1000 micron – 5 to 10 %
  Medium – 300 micron to 1000 micron – 65 to 75 %
  Fines - < 300 micron -  20 – 25 %
  Over size flour is separated through a vibrating screen or rotary screen and recycled back to mill for grinding again.
LIQUEFACTION

• Pre masher – It is a screw conveyor, hot water and other recycling streams like spent lees and thin slope are being mixed with flour to make slurry and transferred to slurry tank.

• Slurry Tank – It is a vertical cylindrical tank equipped with agitator for proper mixing. Open steam is being applied to maintain the temperature 60 degree C. Alkali is added here to maintain the optimum pH 5.8 – 6.0, 30 % of Alfa amylase enzyme dose is added here.

• Jet cooking – Slurry is passed through a jet cooker where saturated steam of medium pressure is applied for cooking. Temperature of jet cooker is maintained 110 – 120 degree C depending on grain.

• Retention vessel / coil – Retention vessel or Coil is used just after the jet cooker to provide retention time in pressurized condition for Proper starch conversion.
• **Liquefaction tank** - Cooked slurry is now transferred to Liquefaction tank. Balance quantity of Alfa amylase enzyme dose is added in liquefaction tank. Temperature is maintained 90 degree.

• Slurry is now passed through Plate heat exchanger and cooled to 32 degree temperature and send to fermentation.

• **Now days use of jet cooker is being stopped and single vessel liquefaction system has been started in industries.**
FERMENTATION

• **PRE FERMENTER** – Pre fermenter is used as yeast activation tank. Instant Dry yeast is mixed with liquefied slurry in pre fermenter and vigorous aeration is provided. PHE is used for temperature control. Approximate 6 Hrs time is required for activation.
  
• Set up gravity of pre fermenter - 1.050

• Specific gravity at the time of transfer to fermenter – 1.030

• **FERMENTER** –
  
  • M.O.C. – S.S. 304 or M.S. with Epoxy coating.
  
  • Equipped with – Agitator, PHE, cleaning nozzle and Breather valves.
  
  • Initial sp. gravity of slurry – 1.090 – 1.10
  
  • Sp. Gravity at the time of set up – 1.065 – 1.075
  
  • Alcohol in wash – 13.5 – 15 % v/v
  
  • Filling time – 16-20 Hrs
  
  • Fermentation time – 32 -36 Hrs
  
  • Settling time – 6-8 Hrs
  
  • Total time – 60-65 Hrs
  
  • Residual starch – 0.4-0.5 %
  
  • Residual Sugar – 0.1 – 0.2 %
DOSES

• ENZYME
  • Alfa amylase – 0.4 to 0.5 Kg / Ton Starch (Liqueflow)
  • Amylo glycosidase – 0.8 to 0.9 Kg/ Ton starch (Sachzyme Plus)
  • Yeast – 0.2 Kg/ Ton Starch

• Nitrogen source Urea – 400 PPM of wash (If we use Liquor Ammonia for pH correction then Use of urea is required 250 PPM only.

• Liquor Ammonia/ caustic – As per requirement to maintain pH
• Biocide – 2 -3 PPM as per requirement
• If low pH enzymes are used, no alkali is required for pH correction.
DISTILLATION

• Multi pressure Distillation Plant is a set of columns integrated with each other for optimization of steam consumption. The modern MPR Distillation plant comprises of the following columns -
  • Analyzer column
  • Degasifying column
  • Pre rectifier column
  • Extractive Distillation column
  • Rectifier column
  • Simmering / Refining column
  • Recovery column
MPR DISTILLATION
**DECANTATION**

- Spent wash which comes out from Analyser column contains 6 – 7% solids. It is passed through Decanter centrifuge to separate the suspended solids present in spent wash. The part of suspended solids separated out containing 70% moisture is termed as wet cake or DWGS (Distillers Wet Grain Solubles).
- DWGS directly may be used as cattle feed or it can be dried to convert in to DDGS.
- Decanter centrifuge make –
  - Alfa Laval
  - Hiller
  - Hamboldt
EVAPORATION

• Evaporation and DWGS dryer has been incorporated in the process of Distilleries to maintain the Zero liquid discharge.

• After separation of suspended solids from spent wash the supernatant obtained from decanter is termed as thin slope.

• Thin slope containing solids approximate 2.5 % is send to Multiple effect evaporator to enhance the concentration up to 32 – 35%.

• Multiple effect evaporator is a set of falling film and forced circulation evaporator bodies. Normally 5 effect or 6 effect evaporators are in use.
• In modern distilleries no steam is consumed to operate the evaporator. Only heat of vapors from different columns of distillation columns is being utilized to operate the evaporator by means of integration.

• By integration we save steam as well as cooling water to operate the distillery.

• The thin slope is being concentrated up to 32 -35 % solids termed as thick syrup is mixed with DWGS and send to Dryer for producing DDGS.

• Process condensate obtained from MEE (Multiple Effect Evaporator) is re-used in process or cooling water make up after necessary treatment.
INTEGRATED EVAPORATOR
DWGS DRYER

• DWGS obtained from decanter and Thick syrup from Evaporator are mixed with each other in a Ribbon mixture and fed in to Dryer to reduce the moisture. DDGS comes out of Dryer which contain 8-10% moisture.

• There are two types of DWGS Dryers in practice -
  • Rotary tube Bundle Dryer.
  • Fluidized bed Dryer.
  • Rotary tube bundle dryers are most successful dryers in Distilleries.
CONденSATE POLISHING

• Condensate obtained from evaporator contains following parameters –
  • pH – 3.8 – 4.0
  • C.O.D. – 1500 – 2000 PPM
  • TDS – 150 – 200 PM
  • Volatile Acids – 350 PPM
• The condensate of above characteristics is required to be treated before it is reuse.
  • Flocculation and Nano filtration.
  • Anaerobic and aerobic treatment.
UTILITIES CONSUMPTION

• STEAM –
• Distillation – 2.6 – 2.8 Kg / liter Production
• Liquefaction – 0.45 Kg/ liter Production
• Evaporation – 0
• DWGS Dryer – 1.5 Kg /liter Production (1.3 – 1.35 Kg / liter water evaporation).
• Steam consumption may vary according to grain used.
• ELECTRICITY – 0.5 KWH / Liter Production
• WATER – 9.5 Liter / Liter Production
## GRAIN BASED DISTILLERY OPERATION : 50 KLPD : WITH MULTI EFFECT EVAPORATION (MEE) & DRYER ROUTE WATER BALANCE.

<table>
<thead>
<tr>
<th>Total Water Inputs</th>
<th>Total Water Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process water in LIQN &amp; Fermentation</td>
<td>163 KL</td>
</tr>
<tr>
<td>Steam Condensate</td>
<td>254 KL</td>
</tr>
<tr>
<td>Soft Water for RS dilution</td>
<td>115 KL</td>
</tr>
<tr>
<td>Spent Lees PR</td>
<td>96 KL</td>
</tr>
<tr>
<td>Soft/RO Water for boiler feed</td>
<td>320 KL</td>
</tr>
<tr>
<td>Spent lees rectifier</td>
<td>115 KL</td>
</tr>
<tr>
<td>Soft water for analyser flash tank</td>
<td>0 KL</td>
</tr>
<tr>
<td>Process Condensate</td>
<td>137 KL</td>
</tr>
<tr>
<td>Soft water for vacuum pump &amp; others</td>
<td>20 KL</td>
</tr>
<tr>
<td>Soft water for vacuum pump &amp; others</td>
<td>20 KL</td>
</tr>
<tr>
<td>Blending (5000 Cases)</td>
<td>30 KL</td>
</tr>
<tr>
<td>Water in IMFL product</td>
<td>30 KL</td>
</tr>
<tr>
<td>Makeup water for cooling tower</td>
<td>430 KL</td>
</tr>
<tr>
<td>CT Evaporation &amp; Drift losses</td>
<td>380 KL</td>
</tr>
<tr>
<td>Cooling tower blowdown</td>
<td>50 KL</td>
</tr>
<tr>
<td>Misc Washing water</td>
<td>10 KL</td>
</tr>
<tr>
<td>Washing water</td>
<td>10 KL</td>
</tr>
<tr>
<td>Other Domestic usage</td>
<td>10 KL</td>
</tr>
<tr>
<td>Domestic effluent</td>
<td>06 KL</td>
</tr>
<tr>
<td>Total water input /Day</td>
<td>1098 KL</td>
</tr>
<tr>
<td>Total water output/day</td>
<td>1098 KL</td>
</tr>
</tbody>
</table>
GRAIN BASED DISTILLERY OPERATION : 50 KLPD : WITH MULTI EFFECT EVAPORATION (MEE) & DRYER ROUTE)
WATER BALANCE.

Recycle & Utilization Streams

Recycle due to MPR Distillation

- PRC lees Recycle for liquefaction: 96 KL
- Steam condensate Recycle for Boiler: 254 KL
- Spent lees (Rect )-Cooling towers makeup: 115 KL

Recycle due to MEE

Other possible recycles in Grain process

- Thin Slops recycle to Liquefaction process: 71 KL
- Process condensate after treatment in CPU: 137 KL

Total water recycle /reuse per day: 673 KL

Total fresh water input /day: 425 KL

Total: 8.50 KL/KL
THANK YOU