Present Status of Feedstock Management & Technology Developments in Ethanol Sector

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Feedstocks For Ethanol Production

- **Sugars: –**
  - **Sugarcane,**
  - **sweet sorghum,**
  - **sugar beet,**
  - **molasses (by-product of sugar production) - ‘A’, ‘B’ & ‘C’ heavy molasses**
  - **fruits etc**
- **Starches: –**
  - **Grains (Corn, wheat, rice, barley, sorghum) etc**
  - **Tubers (Cassava, potato etc)**
- **Cellulose – Grass, wood, MSW etc**

Indian Feedstocks

- **Molasses** – main raw material + 90% of Ethanol/Alcohol Production
- **Sugarcane** – technology available and tested but cannot be used as sugarcane price very high – unviable for Ethanol
- **Sweet Sorghum** – high yielding variety being developed. Production technology being tested – one plant set up – This year commercial production.
- **Tropical Sugar Beet** – high yielding variety being tested – plant set up – trials taken - This year commercial production

Indian Feedstocks

- Fruits – only for **wine**
- Grains used for **potable alcohol** production as it is **costly** – rice, sorghum, barley, malt
- Damaged/unusable grain – sorghum
- Tubers – Cassava has been used in south India for **potable Alcohol**
- Cellulose – Technology not yet developed

Indian Feedstocks

- Molasses **most economical feedstock**
- Sugarcane **most energy efficient crop** - hard to beat.
- However, water intensive & one year crop.
- Negative impact in draughts and cost of production rises dramatically by up to 30% but not as volatile as crude oil
- During drought, less water intensive crops may be economical
  - Sweet sorghum/tropical sugar beet – about 4/6 months crop water intensity 1/3

Indian Ethanol Potential

- This year's 12 mill T of Molasses availability (for Ethanol). Can produce **2.7 bill L of Ethanol**
- Surplus Sugar produced this year 9 mill Tonnes – no where to sell as surplus in the world – glut !
- 5 mill tonne of sugar/ can be converted to **2.8 bill L of Ethanol**
- E10 Blending Program requires **1.2 bill L of Ethanol**

Indian Ethanol Potential

- 1 mill ha (of 60 mill ha) of irrigated land can produce 5 bill L of Ethanol
- 5% damaged grain – 11 mill T can produce – 4 bill L of Ethanol
- Surplus Biomass of 500 mill T can produce 100 bill L per year
- Or 50% of 120 mill T of Bagasse from sugar mills can produce 12 bill L of Ethanol

Indian Ethanol Blending Program (EBP)

- Ethanol Used in WW II – 'Power Alcohol' in UP
- Technology Azeotropic distillation using benzene
- Stopped after the War
- R&D & Trials in 1979-80, 91-92,
- Pilot projects in 2002 – 3 locations, 300 dispensing stations

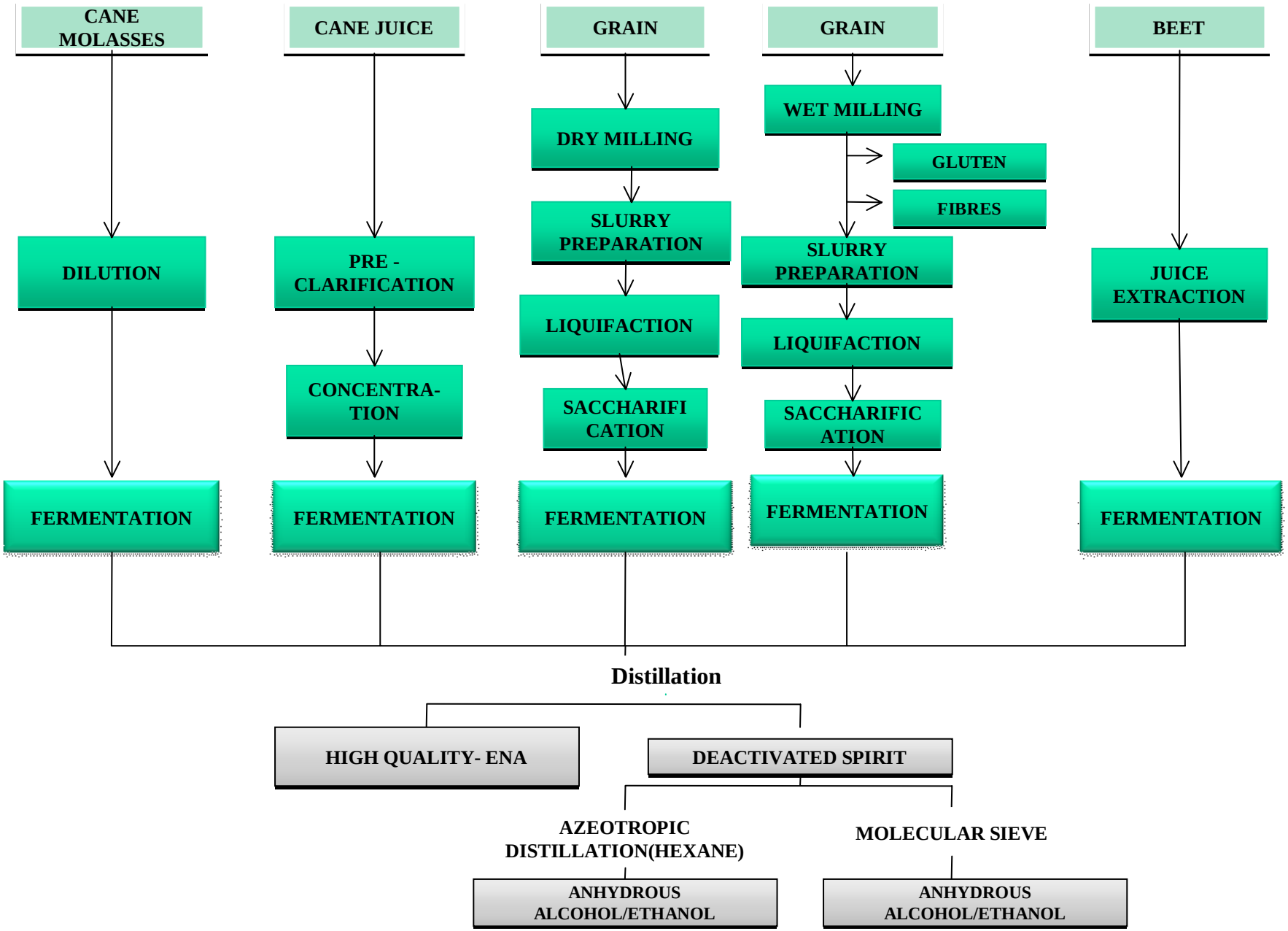
Indian EBP

- **E5 blending made mandatory in 9 states & 4 UTs from Jan 1, 2003**
- Made conditional from **Oct 2004**
- Resumed in 2006 & picks up momentum in 2007 – E5 introduced in Delhi 1st time !
- Announcement to introduce E5 in all India except J&K, NE and Islands
- Intention to introduce E10 by Nov 2008
- Alcohol capacity of +3.5 bill L
- Installed Ethanol capacity of about 1.5 bill L

Ethanol Requirement for EBP

Year	% Blend	Ethanol Requirement (MMT)	Gasoline Demand (MMT)
2006/07	5	0.5	10.07
2011/12	10	1.29	12.85
2011/12	25	3.21	12.85

Feedstocks for Ethanol Production



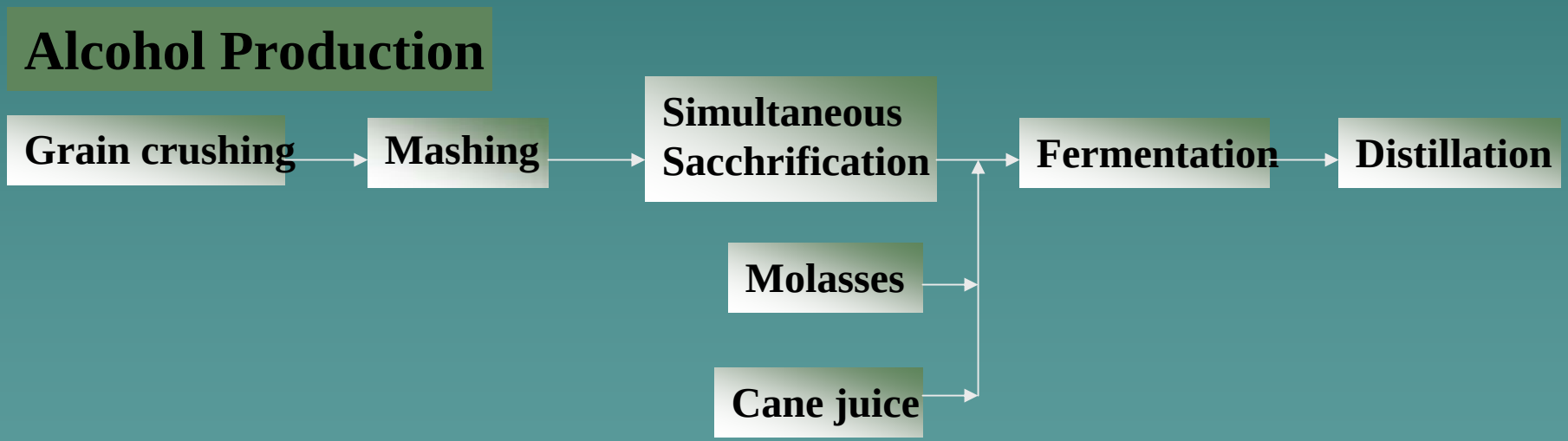
Status of Indian Ethanol Technology

- Average capacity of plant 40 KLPD as against 300 to 1000 KLPD in USA/Brazil
- Level of average technology improving
- Cost of production – economies of scale will be achieved as EBP progresses
- Some Plants converting to multi feedstock plants
- Price around Rs 21.50 per L can be brought down if blending program is expanded
- Small inefficient plants will die !

Ethanol Process Technology

- Process steps in Ethanol Production Technology:
  1. Convert starch to sugar
  2. Ferment Sugar using yeast to produce weak solution of Alcohol (7% to 9%)
  3. Distill alcohol to around 95% V/V
  4. Dehydrate Alcohol using Mol. Sieve to +99.7%
- For Molasses step 1 is avoided – Technology using Molasses and some grains is well established
- However technology being commercialized to handle sugar beet and sweet sorghum
- Continuous fermentation technology becoming popular especially larger Plants

Simplified Ethanol Process Flowsheet



Fermentation Technology

- Batch Fermentation – being phased out
- Continuous Fermentation:-
  - without yeast recycle
  - or with yeast recycle
- Theoretically yield (fermentation efficiency in ascending order but in actual practice may not be so)
- Effect of quality of molasses & control of operation

Fermentation Technology

- Higher efficiencies being attained despite the molasses quality deteriorating
- Ethanol from ‘A’ heavy molasses and ‘B’ heavy molasses no problem
- Ethanol from Sugarcane juice not in use but feasible by adding clarifying and evaporation equipment

Distillation Technology

- Atmospheric Distillation being phased out
- Multi pressure (pressure-Vacuum) technology becoming popular
- lower steam consumption & downtime
- Introduced much earlier in India – ahead of Brazil in energy efficiency
- Reboilers instead of direct sparging of steam
- Lower water consumption

Dehydration Technology

- Ethanol Production
  - Technologies
    - Molecular Sieve (MS) - Technology of 90s
    - Azeotropic Distillation(AD) - Old Polluting Technology
    - Membrane - Yet to be stabilized - Membrane life
- Molecular Sieve technology under license from US firms – Pressure Swing Adsorption (PSA) process
- Low steam consumption of 0.6 kg per L of Ethanol & long life of Mol sieve established – ahead of Brazil
- Higher level of Instrumentation and DCS/PLC systems being introduced in almost all in new plants

Effluent Treatment & Utilities

- Distillery Effluent very rich in organic matter – very high BOD and COD
- Major Issue & also an opportunity to use rich humus and nutrients in effluent
- Zero effluent discharge
- Primary Effluent Treatment Bio-methanation
- Bio-composting using press mud from sugar mills and distillery effluent
- Reverse osmosis/Evaporation being used to reduce quantity of effluent, increase DS and reduce water consumption by recycling
- Incineration in Boilers or spray drying
- High Water use issues –being addressed

Effluent Treatment & Utilities

- Efficient Bio-methanation provides up to 90 to 100% of Fuel for steam for distillation and dehydration
- Increasingly Ethanol plants are integrated with sugar mills and have their own high pressure boilers and turbines with alternators to generate power not only for the Distillery / Ethanol plant but also for the offices and residences or other industrial uses such as Alcohol based chemicals etc.

Technology & Plant Sourcing

- All Alcohol/Ethanol Plants made in India
- Indian Alcohol/Ethanol technology and plant suppliers have arrived on the world stage !
- Plants being sold in all most all continents
- Indian Alcohol technology and plants being sold all over the world because it is efficient and with lower capital costs

Thank You !