Diffusers vs. mills with regard to energy conservation



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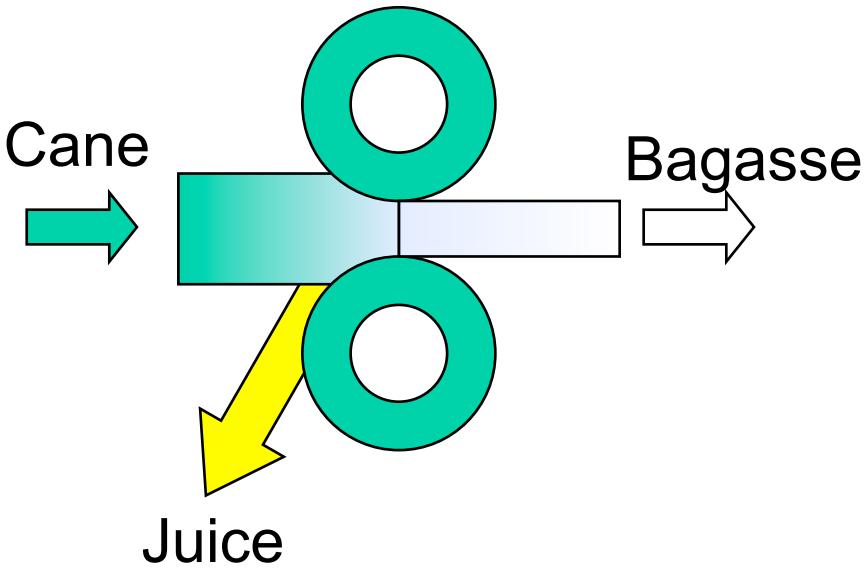
Principles of Mills and Diffusion

Mills

mechanical extraction

- The sucrose contained in the plant cells is extracted by applying pressure to the cells

  - transfer of the sucrose in the liquid only by destroying the the cane cells by milling

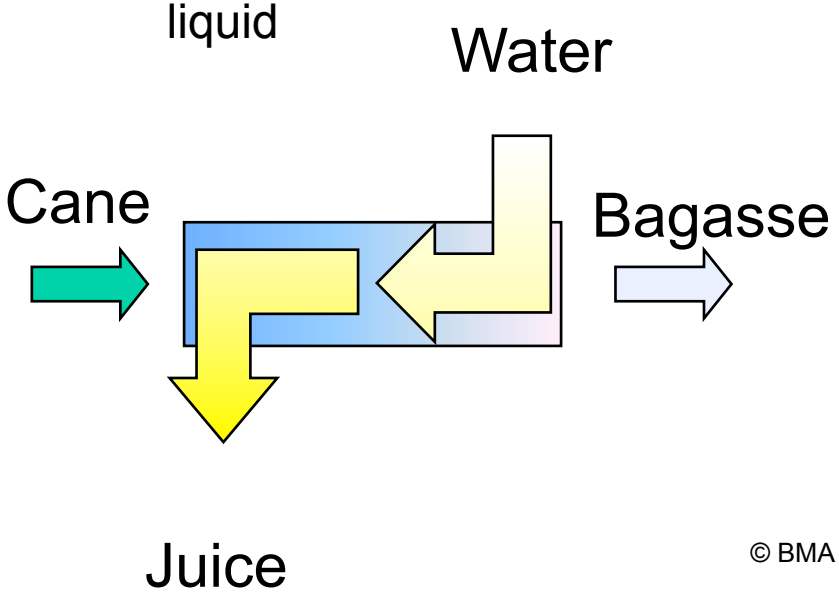


Diffusion

Solid-liquid extraction

- The sucrose contained in the plant cells is extracted with the aid of an extraction liquid

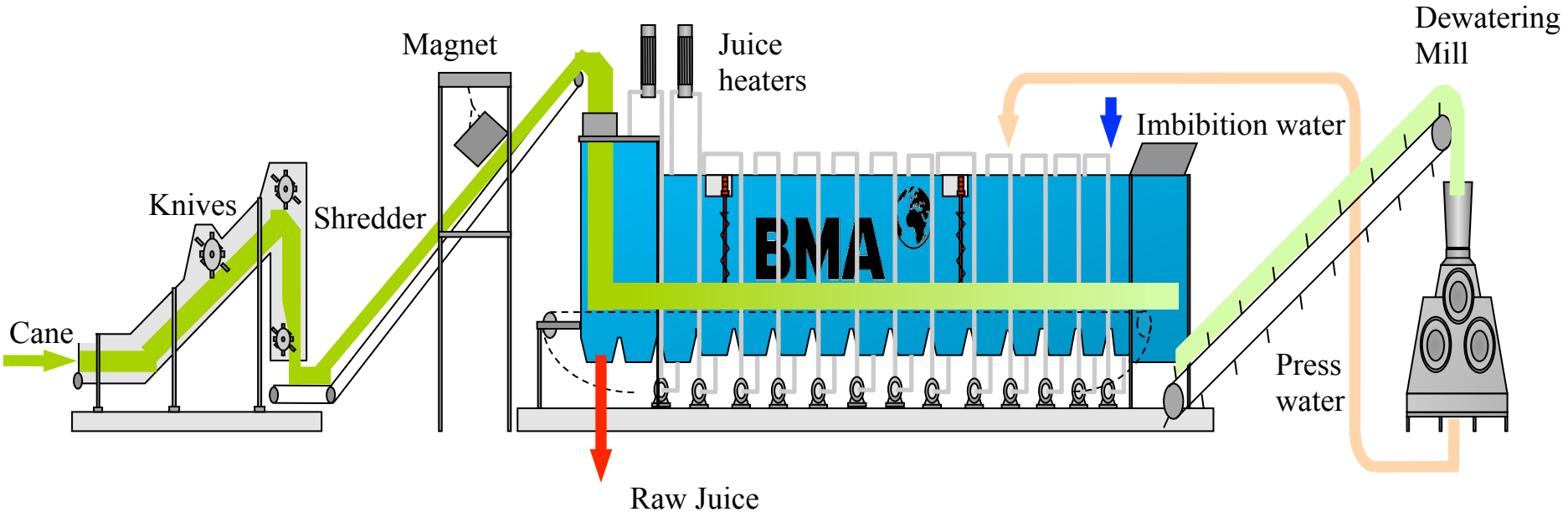
  - transfer of the sucrose to the surface of the cane, due to the drop in concentration between the cell juice and surrounding extraction liquid





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Cane Diffuser

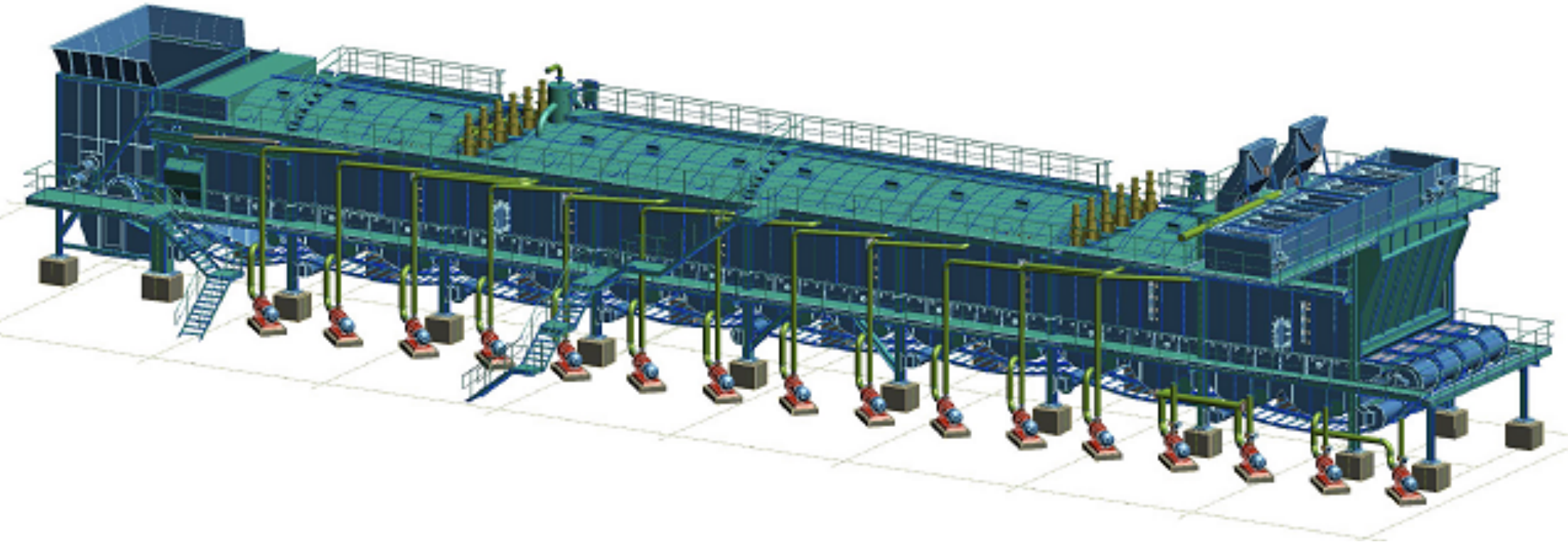


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Technological Description of BMA - Diffuser

End Middle Front

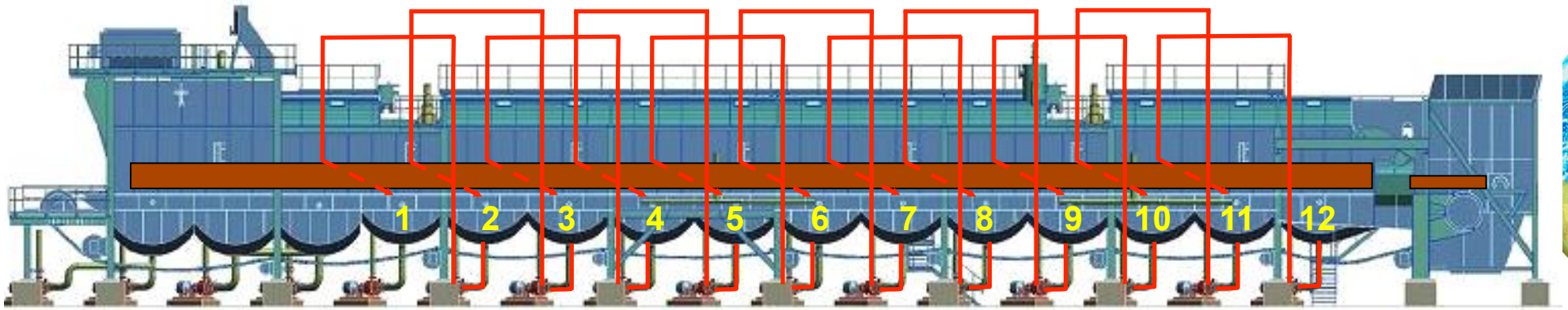


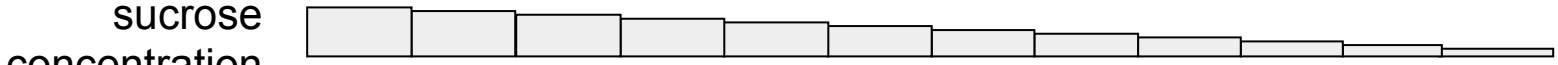
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Operation of BMA - Diffuser

à Percolation





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Principles of Mills and Diffusion

Requirements for a diffuser:

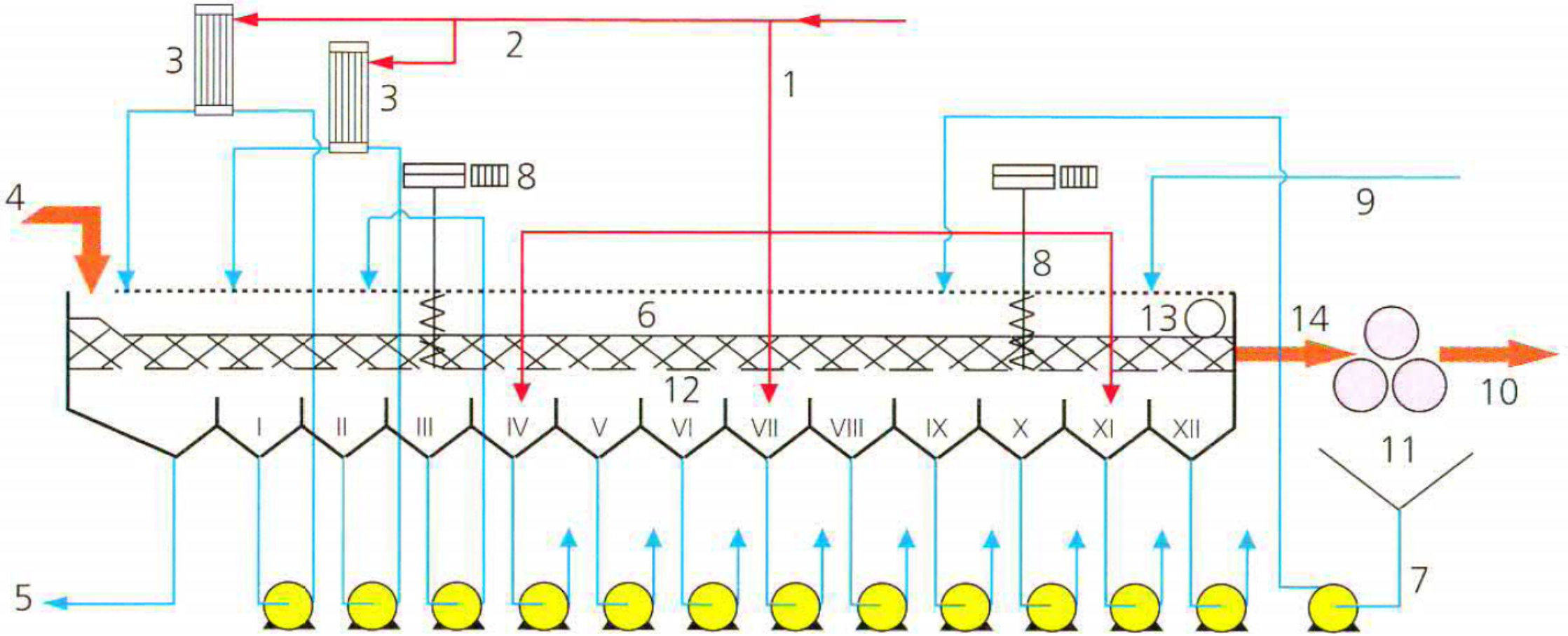
- PI > 90 ➔ Cane preparation by using a heavy duty shredder is necessary
- Cane residence time in a diffuser = 70 – 80 min
- The pH of juice in a diffuser is usually controlled by adding lime into the diffuser. Lime is added to control corrosion ➔ Objective is to keep the pH at about 5,8 to 6,0 in the diffuser
- High temperature in a diffuser of 75 °C is necessary for controlling microbial activity



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Principles of Mills and Diffusion

- Steam requirement for a diffuser



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Advantages of diffuser compared with a mill tandem:

- **Effect on steam balance:**

  Normally, additional heat is required for a diffusion (approx. **10 % o.c.**).
  The raw juice leaving the diffuser is at a higher temperature and so roughly **50 %** of this heat is recovered.

  If vapor 3 is used as heating steam in a diffuser, the total steam amount is then **approx. the same** as for a conventional mill



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Advantages of diffuser compared with a mill tandem:

- **Maintenance + Operation cost:**

  One of the major advantages of diffusion compared with milling is the greatly reduced maintenance + operation cost = approx. **40 %**

- **Capital cost:**

  Capital costs for a diffuser + dewatering mills compared with a full milling tandem = approx. **60 %**



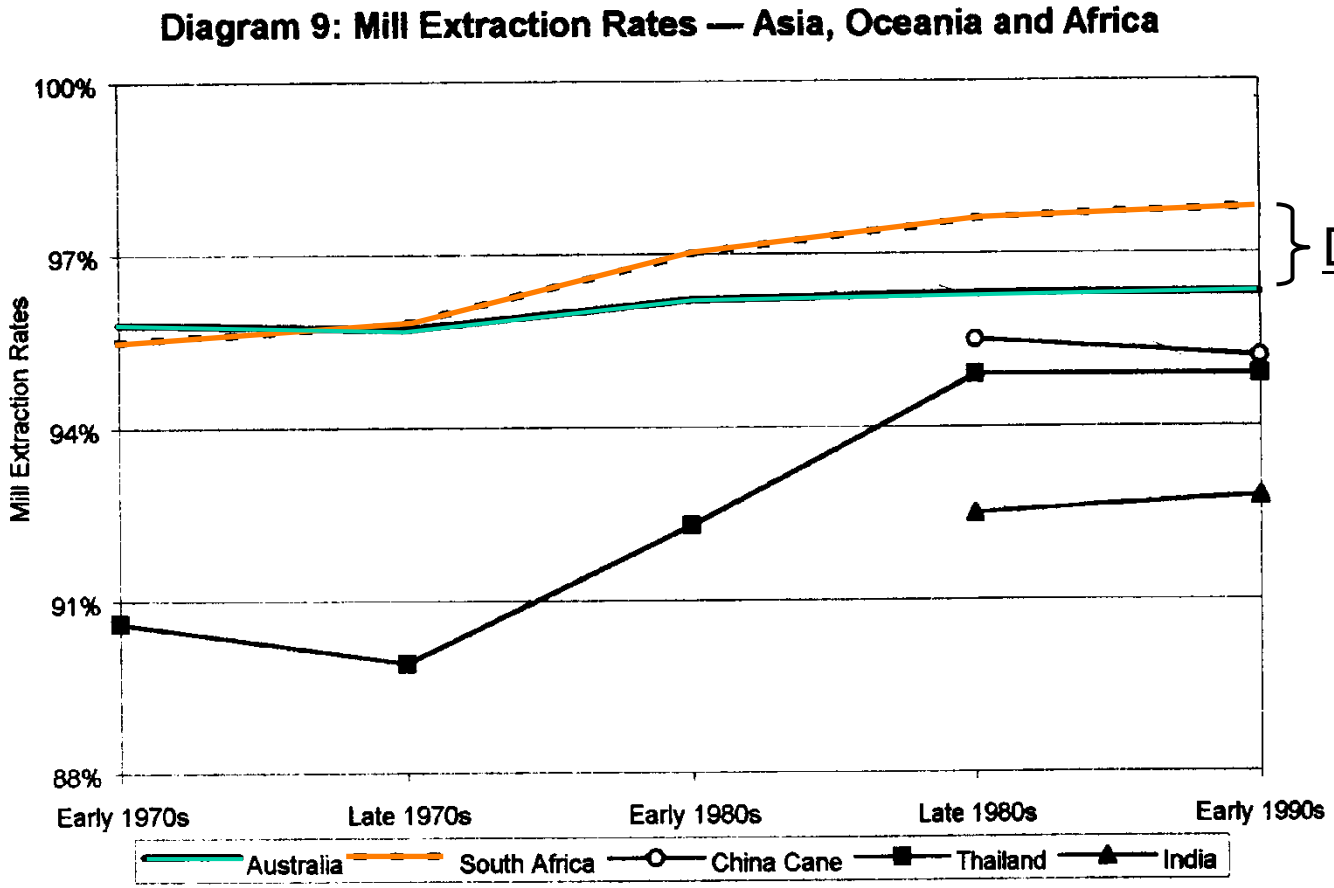
- **Process advantage:**

  Due to the high temperature in a diffuser (75 °C) compared with a mill tandem (35 – 40 °C) The mesophilic organisms are inactive ➔ No biocides are necessary if the temperature is overall > 75 °C

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Advantages of cane diffusion

- High extraction of sucrose
- Impact on national sugar industry performance



Diffusion vs. Mills!



(Proceedings of XXIII ISSCT Congress Plenary Sessions, Dr. J. Fry, International Productivity Comparisons, 1999)

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Advantages of diffuser compared with a mill tandem:

- **Effect on power requirement:**

  A Diffuser is of considerable advantage to a factory that exports power.

  Power consumption without cane preparation:

Mill Tandem:	90 … 100 kW.h/1tcane
Diffuser:	45 … 50 kW.h/1tcane

  ➔ **50 %** of power consumption is saved

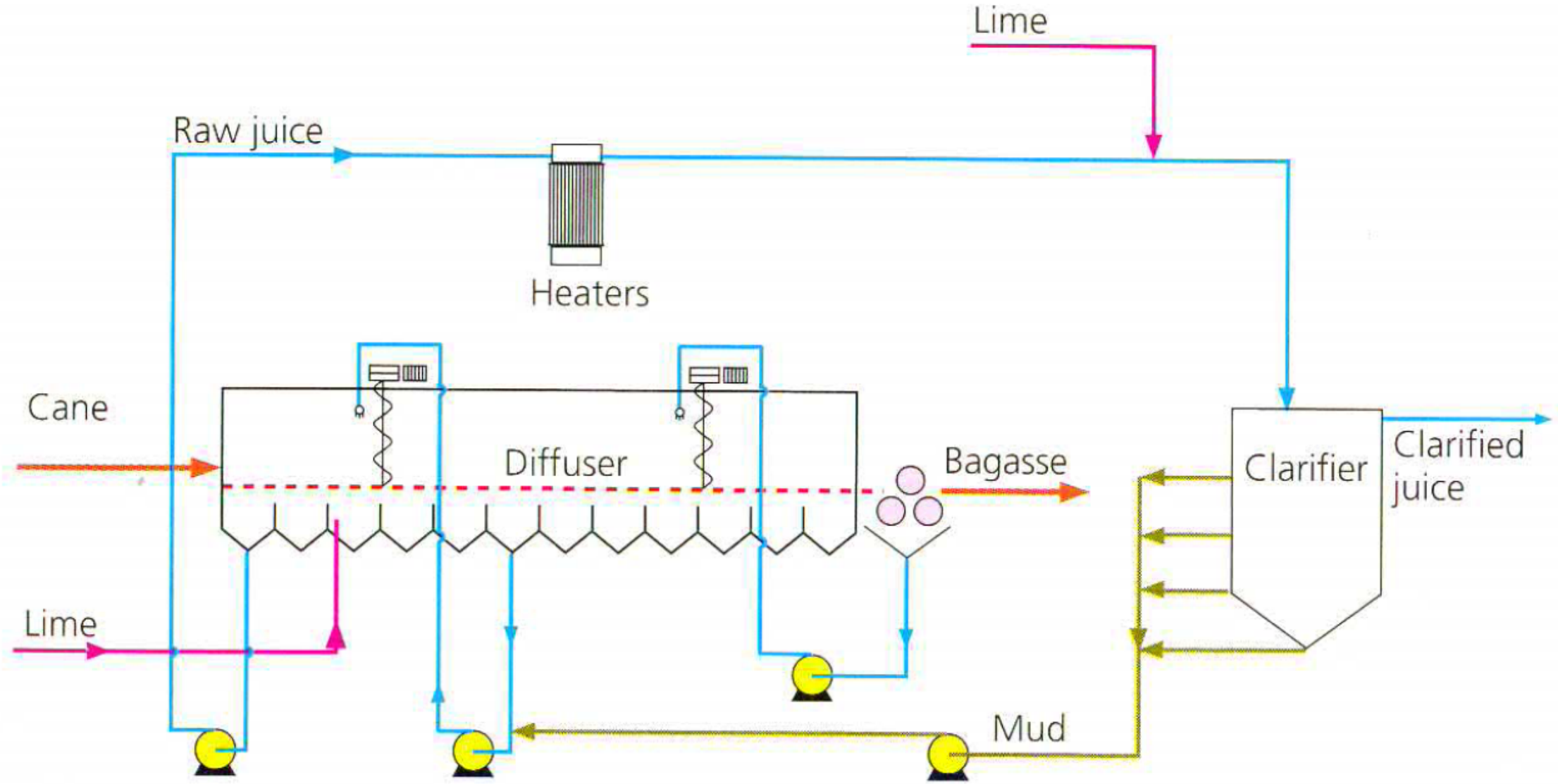
  The power consumption in the filter station is also saved



- Reduction of total power requirement of the factory is by about 5 kWh/tc (approx. from 30 to 25 kWh/tc)

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- Return of mud to the diffuser:



Return of mud to the diffuser:

The return in mud to the diffuser has significant advantages:

- Filter station is no longer necessary
- Loss of sugar in cake is eliminated
- Water washing of cake is obviated, reducing evaporation requirements
- Equipment for bagacillo and cake conveying is not required
- The bagasse supply to the boiler is increased



But:

- The amount of ash in bagasse is increased by about 10 % ➔ **Boiler Design !**

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Summary of results (Mill Tandem vs. Diffuser):

	MILL TANDEM (ACTUAL SITUATION)	DIFFUSER (NOT OPTIMIZED)
Crashing capacity	**6000 STCD** 5443 TCD	**6000 STCD** 5443 TCD
Bagasse to boiler	25,1 %o.c. **56,9 t/h**	25,9 %o.c. **58,8 t/h**
Production A-Sugar	10,4 %o.c. **23,6 t/h**	10,6 %o.c. **24,2 t/h**
Steam demand for Process:	51,7 %o.c. **117,3 t/h**	49,8 %o.c. **112,9 t/h**
Total Steam consumption	53,1 %o.c. **120,3 t/h**	51,1 %o.c. **115,9 t/h**
Surplus Bagasse	0,0 %o.c. **0,0 t/h**	1,6 %o.c. **3,6 t/h**
Power Production	**12,9 MW**	**12,4 MW**
Power Consumption (approx.)	**6,8 MW**	**5,7 MW**
Power Export (approx.)	**6,1 MW**	**6,7 MW**



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Comments welcome !

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Process Fundamentals (I/VI)

- à Particle size
- à Thermal denaturation
- à Extraction temperature
- à Percolation rate
- à pH
- à Imbibition rate
- à Concentration gradient
- à Retention time

à The operation of the solid/liquid extraction process requires defined conditions which are easily adjustable by BMA Diffuser. (PCS)



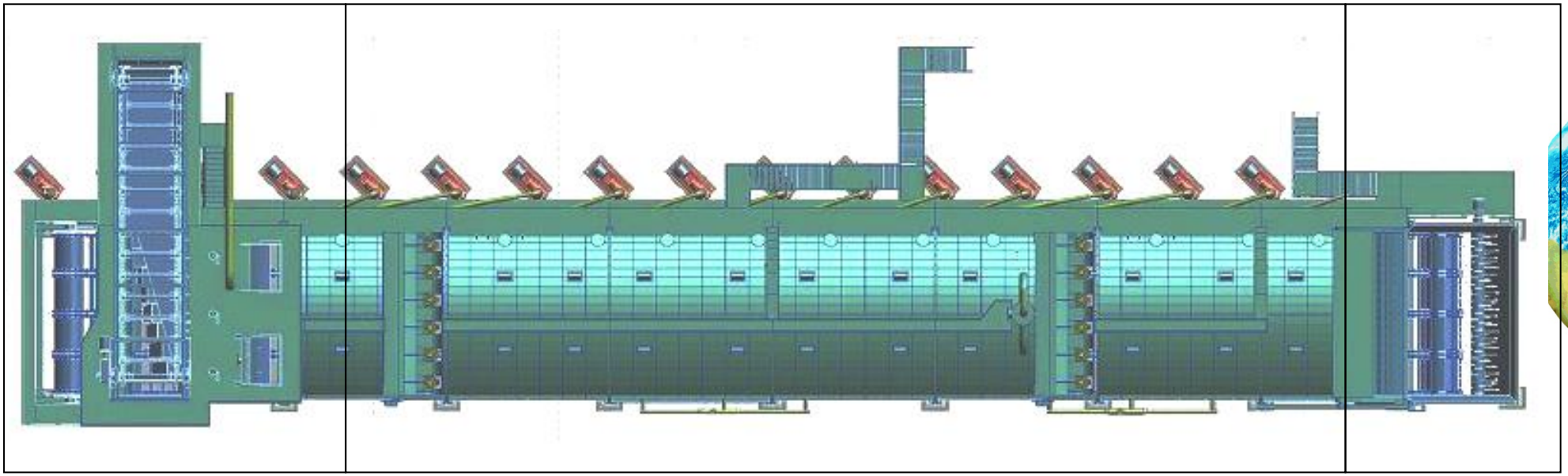
à The solid/liquid extraction process is influenced by certain factors that have to be controlled and kept at an optimum level during the extraction process.

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principle structure of BMA-Diffuser

Front	Middle	End
à Cane Feeding	à extraction of juice from cane	à Pre-dewatering



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Process Fundamentals (II/VI)

à **Particle size**

- The proportion of juice which can be extracted depends on the particle size (smaller particle sizes leads frequently to better extraction efficiency)
- The physical state of the cane particle (shape, size and rigidity) affects the bulk density and compaction of the bagasse bed
- PI value (preparation index) should be between 90 and 94 %



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Process Fundamentals (III/VI)

à **Thermal denaturation**

- applying heat (Liquid) to the plant/cell tissue and opening of unbroken cells by denaturation of the cell walls
- therefore the cell juice is enable to pass through to the cell wall; extraction of the cell juice of the before unbroken cells
- The optimum temperature for denaturation of the cane tissue is in a range between 70°C and 80 °C



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Process Fundamentals (IV/VI)

à **extraction temperature**

l the average extraction temperature is 75 °C, which is advantageous for the extraction rate and for further positive effects such as:

- reduction of the viscosity of the extraction liquid
- reduction of the microbiological activity and of undesirable enzyme activity



à **pH-value**

l constant pH of about 6.2 for juice purities of 78 and over and of 6.0 for purities of 78 and under is essential to avoid a sucrose inversion and the extraction of certain polysaccharides from the fibre

l adjusting the pH by adding lime to the diffusser

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Process Fundamentals (V/VI)

à **percolation rate**

- the percolation rate is the rate which the extraction liquid flows through the bagasse bed in the diffuser.
- The percolation rate is directly related to the preparation of the extraction material and particle distribution



à **Imbibition rate**

- is the rate at which imbibition water is added to the bagasse at the end of the diffuser
- the imbibition rate depends on the percolation rate of the fibre material and of the fibre content of the cane
- to improve extraction, an easy way with diffusion is to increase the imbibition rate

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Process Fundamentals (VI/VI)

à **Concentration gradient**

- describes the relation of sucrose concentration in the material to be extracted and the extraction liquid
- the difference of sucrose concentration is the driving force for the extraction process



à **Retention time**

- describes the time available for extraction inside the diffuser
- solid/liquid extraction is a slow exchange process,

  ➡ longer retention times will increase the extraction but has to balanced against a possible higher sucrose destruction

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principle structure of BMA-Diffuser

Front	Middle	End
à Cane Feeding	à extraction of juice from cane	à Pre-dewatering



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Operation of BMA - Diffuser

à Cane Feeding

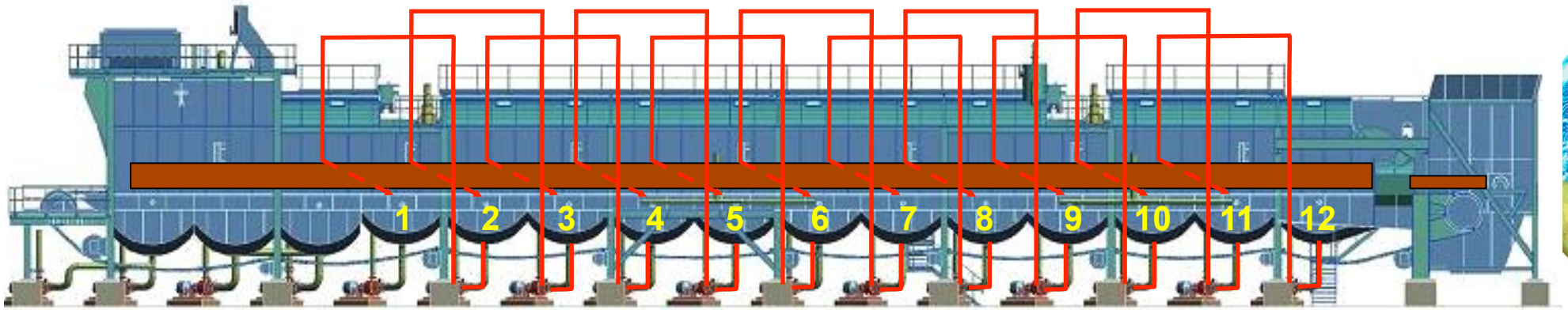


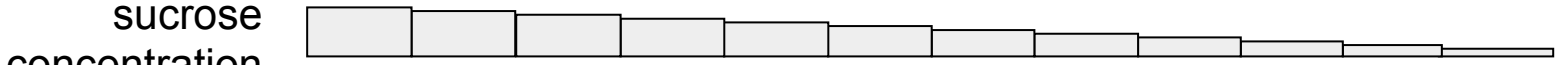
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Operation of BMA - Diffuser

à Percolation



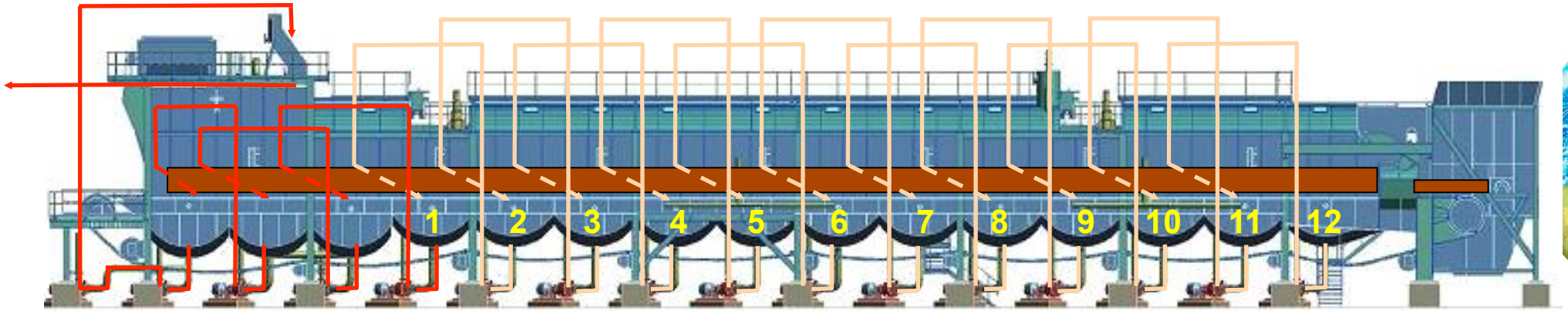


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Operation of BMA - Diffuser

à Percolation



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Advantages of Cane Diffusion (I/V)

ÿ ***High extraction of sucrose:***

Milling train with 5 x 5 roller mills (320 t/h)

Milling train extraction: 97.35%

at CSR Inkerman Mill, Australia

Bagasse diffuser (625 t/h)

at CSR Invicta Mill, Australia

Diffusion train extraction: 98.25%



ÿ**Customer's benefit:**

- Higher revenues per ton of cane

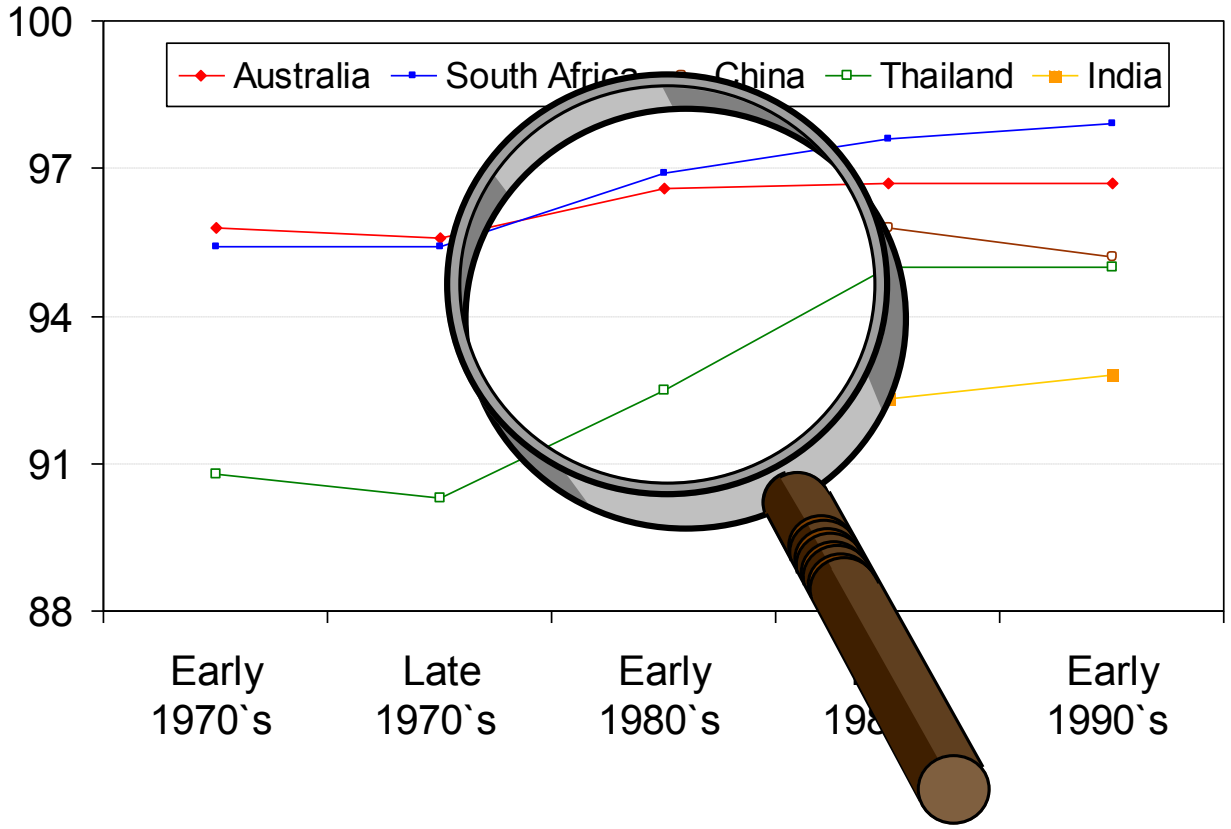
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Advantages of Cane Diffusion (II/V)

ÿ*High extraction of sucrose*

ÿ*Impact on national sugar industry performance*

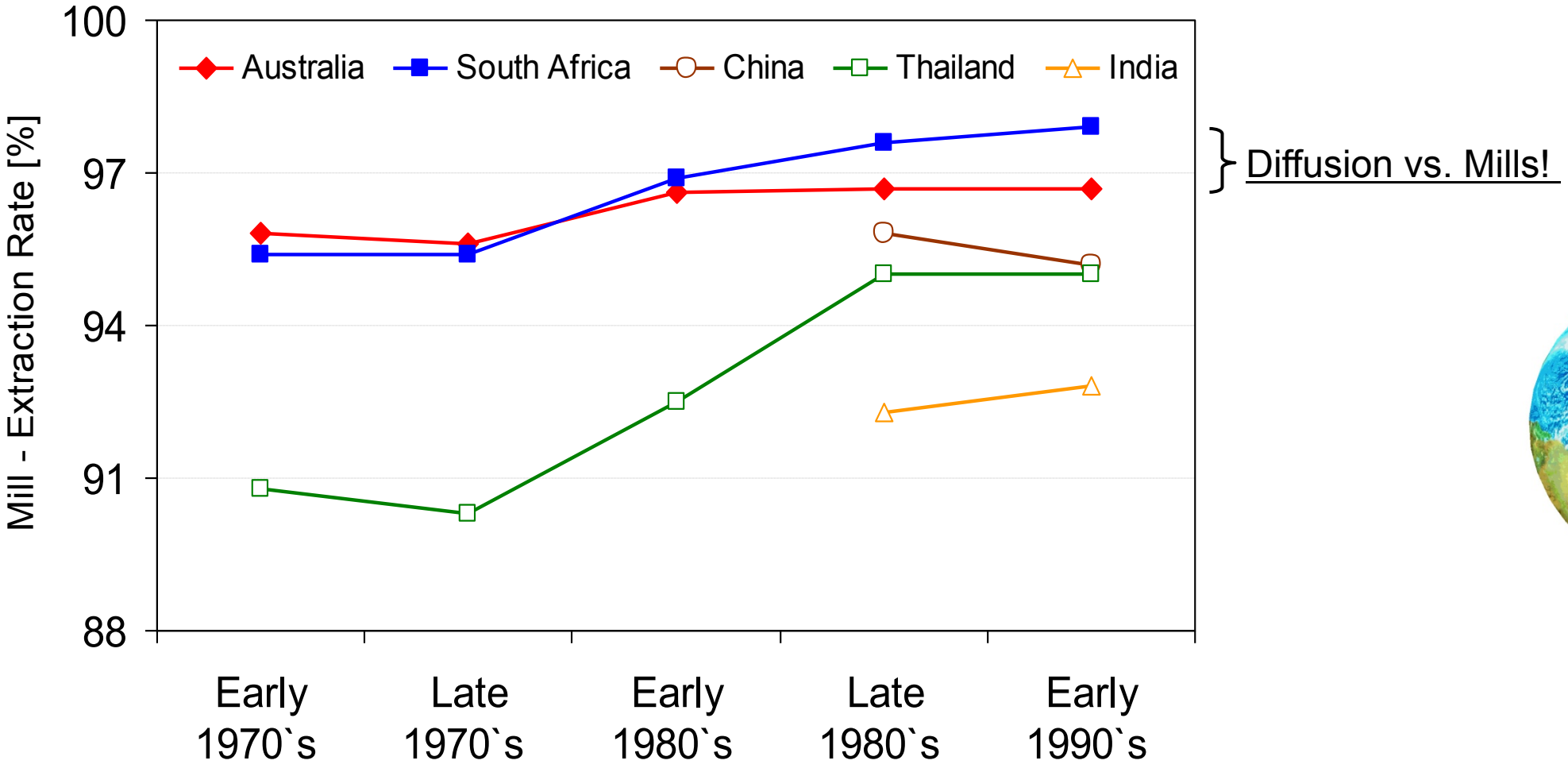




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Advantages of Cane Diffusion (II/V)



} Diffusion vs. Mills!



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(Source: Proceedings of XXIII ISSCT Congress Plenary Sessions, Dr. J. Fry, International Productivity Comparisons, 1999)

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Advantages of Cane Diffusion (III/V)

	ÿ **Customer's benefits**
ÿ Extraction at higher temperatures (75°C) results in sterile juice and reduced bacteria decomposition	l Higher sugar yield
ÿ Only little maintenance required (< 30% of mill tandem)	l Lower maintenance cost
ÿ Reduced number of operators required	l Lower operating cost
ÿ Low wear	l Low maintenance cost
ÿ Diffuser can be located outdoors	l No building required



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Advantages of Cane Diffusion (V/V)

ÿ *Significantly reduced steam consumption by*

- à new patented rain type imbibition
- à better pre-dewatering with dewatering drum
- à mechanical chain cleaning system



ÿ ***Customer's benefit***

l *Maximised export of electrical power to the grid*

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