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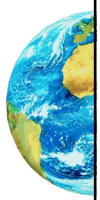
SASTA 2008 Factory Workshop: Lessons learned from the beet sugar industry



SASTA

29th to 31st July 2008 / Durban

Reinhold Hempelmann

Introduction

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- ***History of beet sugar industry in Europe:***
  - In 1980 energy consumption was about twice than today
  - Automation standard was on a low level
  - Sugar house pan operation was mainly manual
- ***Pressure to reduce the energy consumption came from the first oil crisis***
- ***Energy consumption was/is seen as decisive cost factor:***
  - Development of high efficient processes
  - Special view on process water
  - Introduction of first automation systems

Content of the presentation:

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- ***1. Introduction***
- ***2. Development in the last 25 years***
- ***3. Characteristic process data of a modern beet sugar factory***
- ***4. Implementation of a pulp steam dryer***
- ***5. Conclusion***

Content of the presentation:

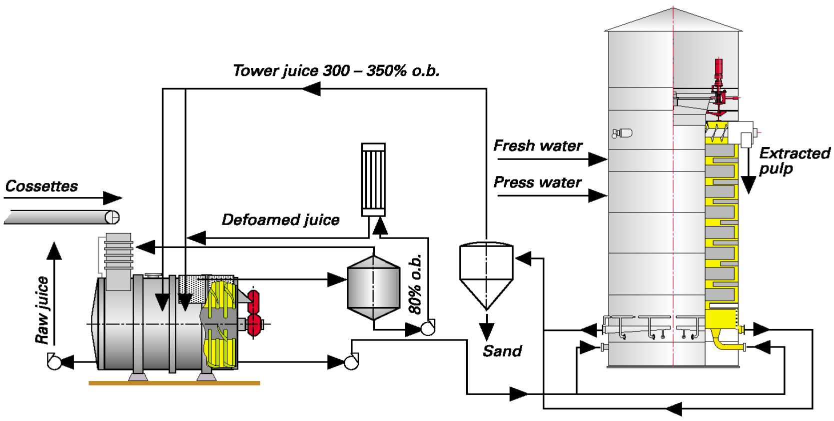
2. Development in the last 25 years (1)

- ***Process characteristics found in most of the beet sugar factories in the 80ties:***
  - Boiler pressures max. 45 bar
  - Raw juice draft in extraction 115% to 125% o. beet
  - Pressed pulp with approx. 25% dry substance content
  - Pressed pulp dried with direct fired drum dryers,
  - Milk of lime preparation with condensate
  - Evaporation stations with 4(5) effects, DS of thick juice 60 to 65%
  - Batch pan operation with slurry seeding or shock seeding
- ***Some typical types of equipment used in the 80ties:***
  - Co-Current cossette mixers (no raw juice cooling)
  - Robert type evaporators
  - Batch pans without agitators, outside circulation, manual operation

2. Development in the last 25 years (2)

- ***Main steps in extraction plant and pulp presses to improve energy efficiency:***
  - Introduction of Counter-Current-Cossette mixer
    - Raw juice cooling typically 15K above cossette temperature
  - Reduction of raw juice draft from extraction plant
    - Depending on concept to 110%o.b., 105%o.b. and lower
  - Increase of DS in pressed pulp continuously to today 30 to 35%
    - Direct fuel saving in direct fired pulp dryers

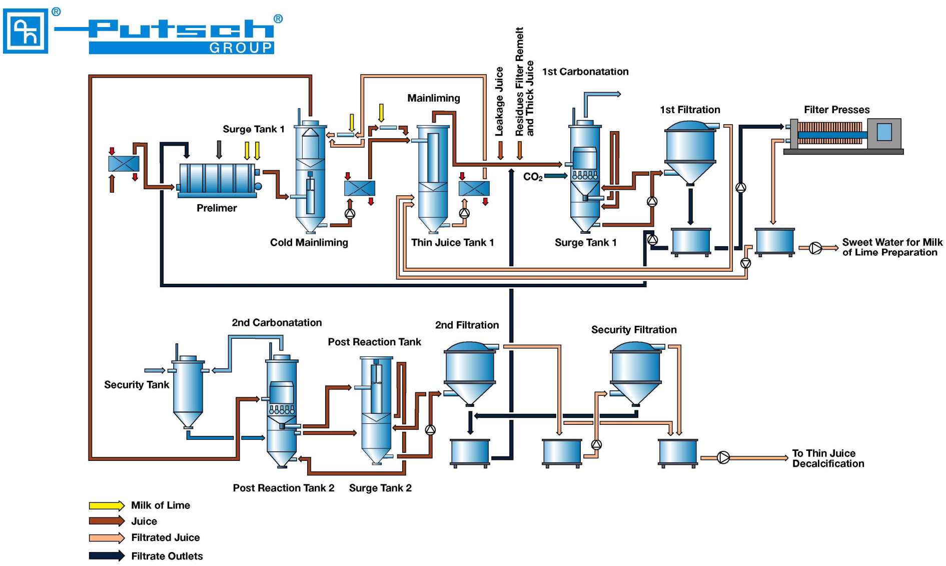
BMA extraction plant



2. Development in the last 25 years (3)

- ***Main steps in juice purification:***
  - Nearly complete elimination of reducing sugars in main liming
    - Temperature stable thin juice
  - Milk of lime preparation with filtrate
    - No additional water into the product
  - Optimization of the process to minimize milk of lime usage
    - Minimizing the recirculation flows
  - Optimization of CO_2 efficiency in carbonation by Richter tubes
    - Control of pH after 2. carbonation avoids scaling in evaporators
  - Frequency drives for flow control vs. control valve
    - Reduction of electrical energy demand

Juice purification – System Putsch



2. Development in the last 25 years (4)

- ***Main steps in evaporation:***
  - Change to 5 or 6 effect evaporation stations
  - Using pre-evaporation in last effects
  - Change to falling film evaporators (FFE)
    - First to tube type FFE than to plate type FFE
    - Low delta T , low residence time = low colour formation
- ***Main steps in heating:***
  - Heating as much as possible with final condensate
  - Raw juice heating with pan vapour
  - Change to plate type heat exchangers
    - Low delta T

2. Development in the last 25 years (6)

- ***Main targets in evaporation station:***
  - Thick juice DS as high as possible
  - Maximum use of waste heat
    - Non-condensable gases
    - Condensate
    - Pan vapour
  - No vapour to the condenser from last effect

2. Development in the last 25 years (7)

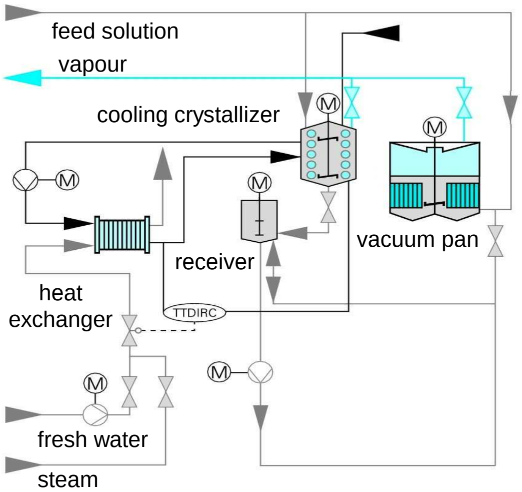
- ***Main steps in sugar house operation:***
  - Batch pans with agitators
    - Improved heat transfer
    - Improved crystal quality
  - Seeding systems for all products
    - Automation of crystallization process
    - Operation with high DS in thick juice und run-offs
    - Constant crystal quality - Precondition for syrup washing
  - Continuous crystallization
    - Continuous flows
    - Operation with low heating steam pressure
  - Syrup washing for batch centrifugals (A and B):
    - Reduction of wash water to 1% on MC at high sugar quality

2. Development in the last 25 years (8)

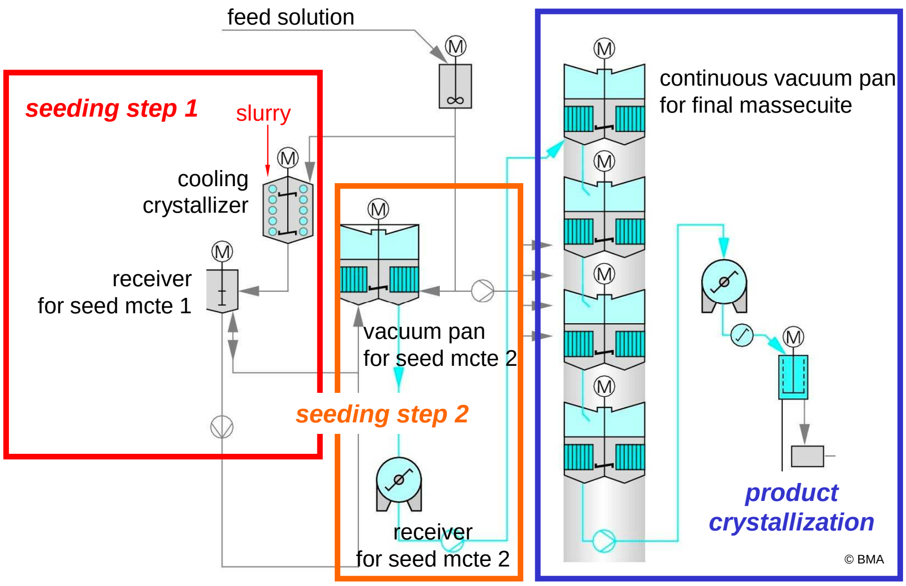
- ***Main target for sugar house operation:***
  - Maximum thick juice DS (today 73-75%)
  - Minimizing the water addition into sugar house products for:
    - Melting of sugar
    - Wash water for centrifugals
    - Cleaning the process area
  - Improvements in general process operation:
    - No product overflows
    - Continuous flows (Steam, product)
    - Constant quality of all products

Seeding plant

- ***Seed:*** ***slurry 10 µm***
- ***1st seed MC ≈100 µm***
- ***2nd seed MC or product ≈ 0.3 - 0.5 mm***



Seed preparation: Two stage seed preparation plant



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VKT A, B, C
Klein Wanzleben

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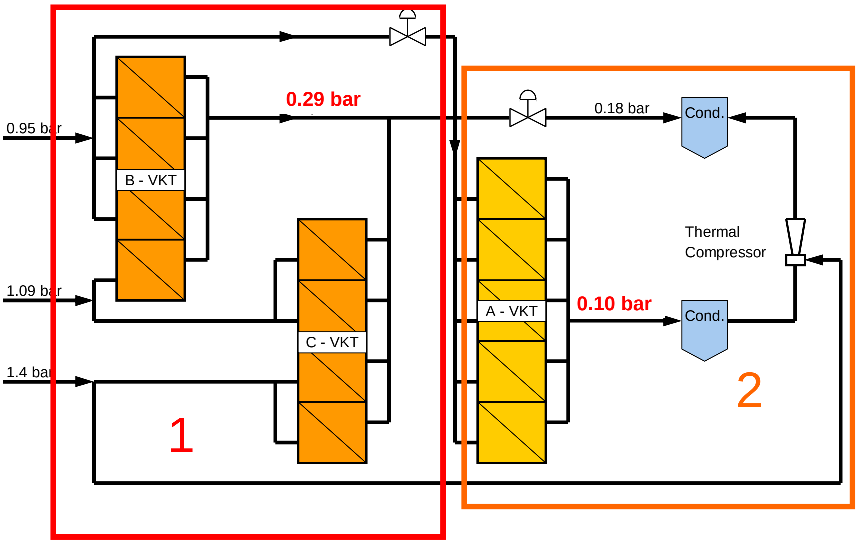
Double-effect evaporation in crystallization



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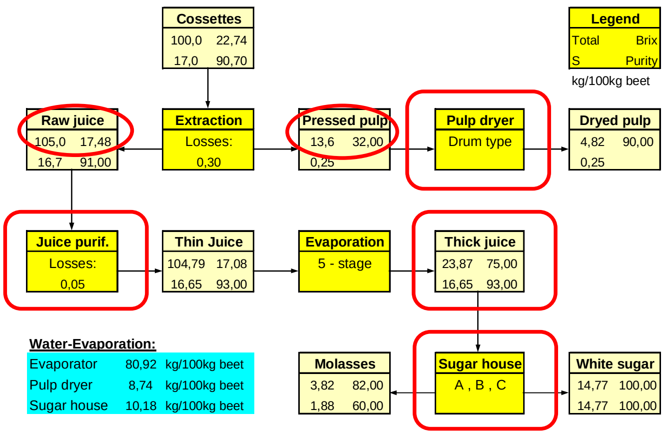
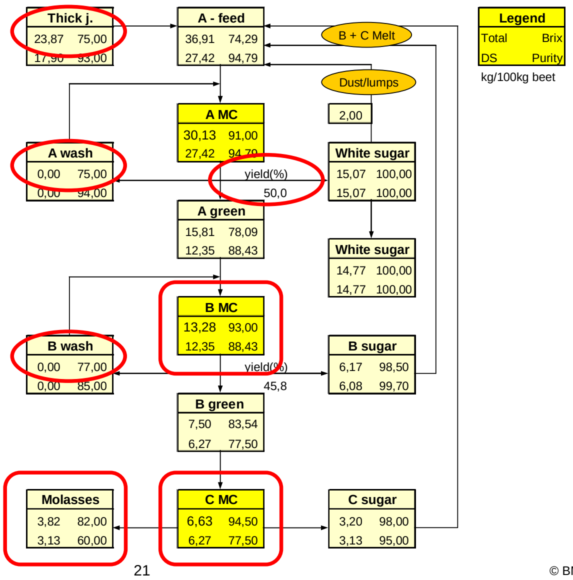
Content of the presentation:

Overall mass balance



Sugar house mass balance



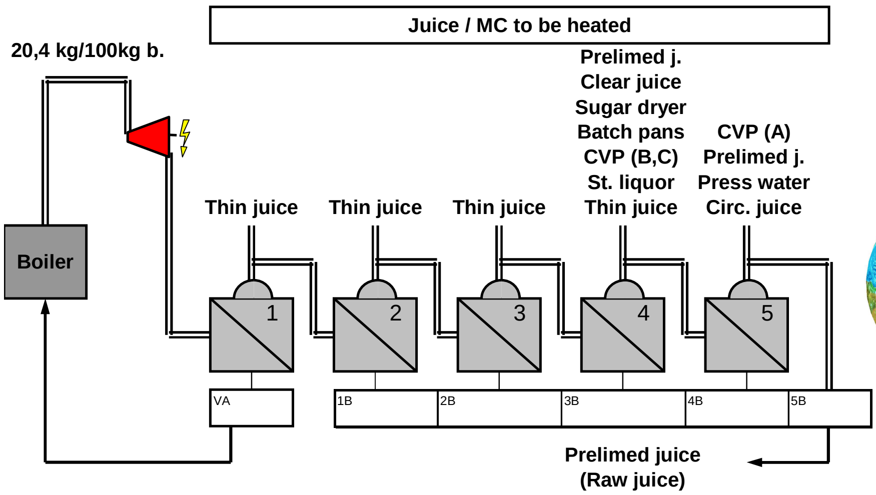
Water-Evaporation:

A MC	6,78	kg/100kg beet
B MC	2,54	kg/100kg beet
C MC	0,87	kg/100kg beet
	10,18	kg/100kg beet

Characteristic process data – 100% sugar house operation

- ***Beet processing rate*** — ***10,000 mt/d***
- ***Energy demand of boiler*** — ***196 kWh/t beets***
- ***Life steam*** — ***20.3 kg/100 kg beets***
- ***Electric power generated*** — ***16.8 MW***
- ***Exhaust steam pressure to 1st effect*** — ***2.7 bar***
- ***Heat exchanger surface required*** — ***approximately 7,000 m²***
- ***Evaporator surface required*** — ***approximately 20,200 m²***

Evaporation station – 100% sugar house operation



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Characteristic process data – 50% sugar house operation

Beet processing rate	*10,000 mt/d*
Energy demand of boiler	*147 kWh/t beets*
Life steam	*15.3 kg/100 kg beets*
Electric power generated	*12.7 MW*
Exhaust steam pressure to 1st effect	*2.7 bar*
Heat exchanger surface required	*approximately 7,100 m²*
Evaporator surface required	*approximately 30,600 m²*

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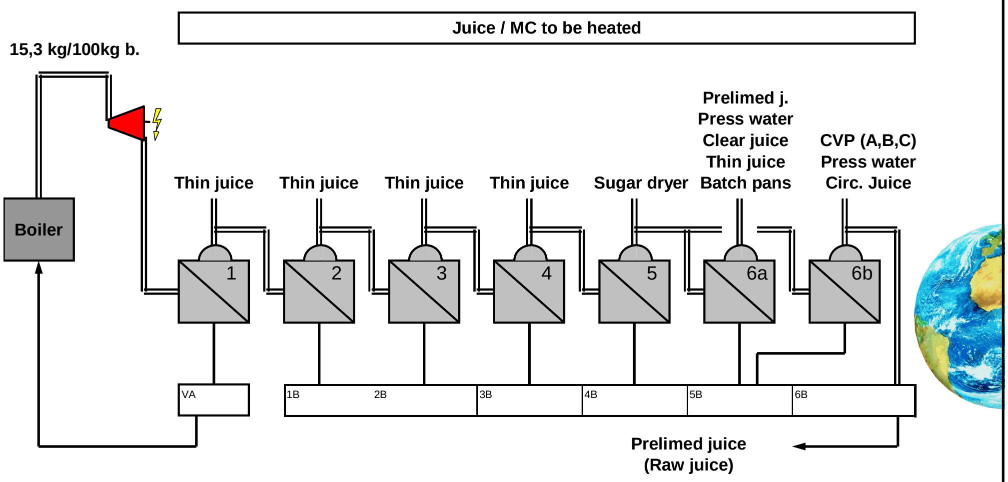
Evaporation station –
50% sugar house operation



- *Thin juice flow: 6a – 1 – 2 – 3 – 4 – 5 – 6b*

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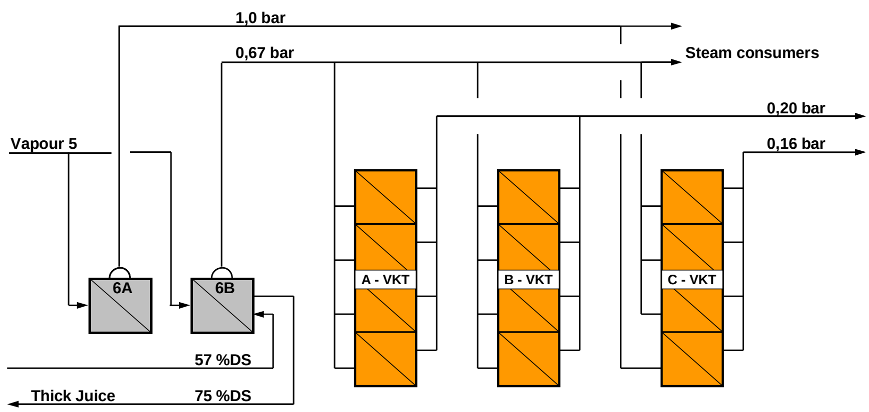
Optimised Design with 3 VKT



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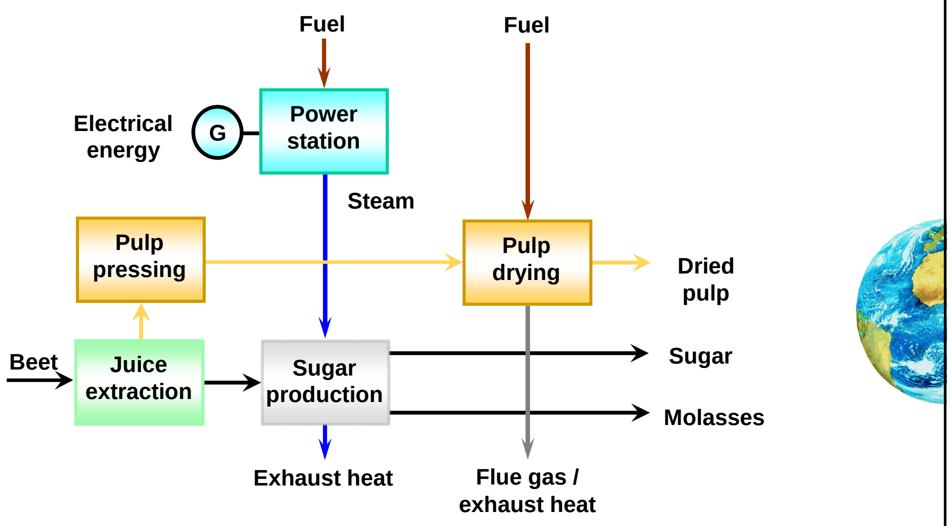
Content of the presentation:

Integration of a fluidized-bed steam dryer

- ***Pulp drying: key factor for energy and environmental concept***
  - About 30 % of total thermal energy with directly fired systems
  - Flue gas accounts for considerable amount of emissions
- ***Steam pulp drying in fluidized bed:***
  - Introduced in the early 1990s
  - Technology has seen decisive developments
  - Processing rates of a single unit: up to 15,000 t/d
  - Primary energy requirements for pulp drying are significantly reduced
- ***Influence on the energy concept:***
  - Steam pressure requirement of 20 to 28 bar reduces amount of produced electrical energy

Integration of a pulp drying plant
- Conventional system -



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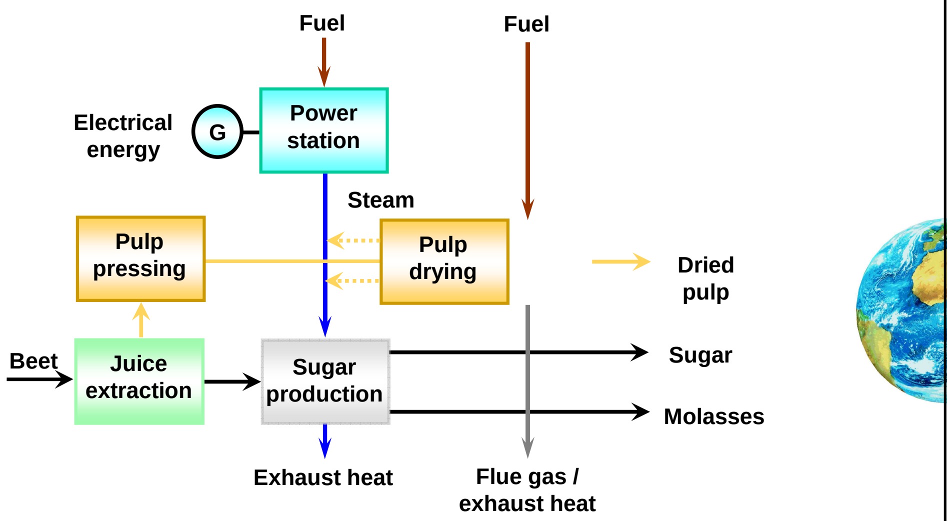
Integration of a pulp drying plant
- Conventional system -



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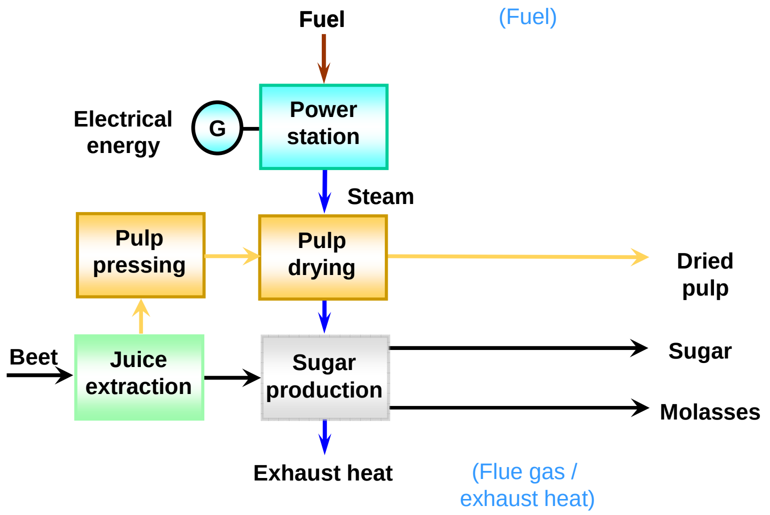
Integration of a pulp drying plant
- New steam dryer system -



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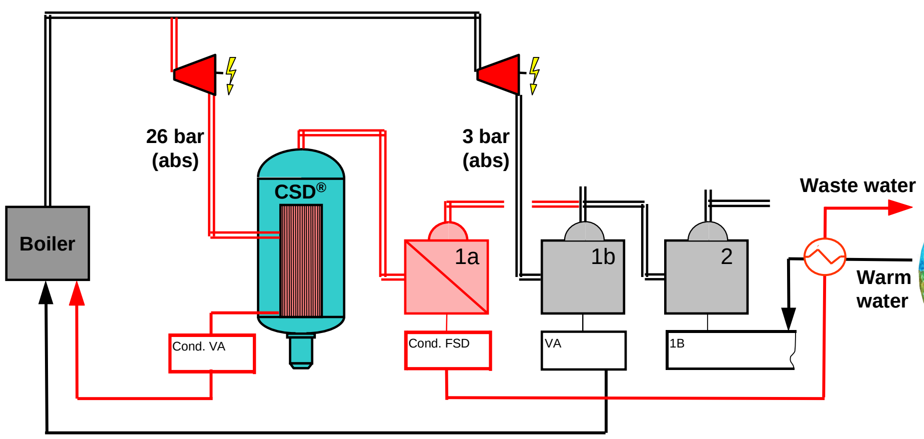
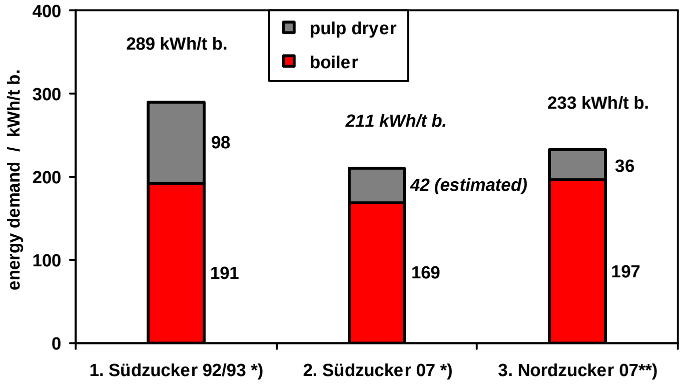
Integration of a fluidized-bed steam dryer



Practical results of German sugar groups



Source:
1. Zuckerind. 118 (2003) 10
2./3. Zuckerind. 133 (2008) 4

*) Some factories with thick juice campaign,
**) some factories with steam dryer

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Conclusion

- ***Energy consumption in beet factories is reduced in the last 25 years significantly by about 50%***
- ***Main areas for savings in process:***
  - Pulp pressing and drying
  - Evaporation
  - Sugar house operation
  - Juice extraction and purification
- ***Main areas in operation:***
  - High standard in automation
  - Strong quality and operation target control

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Conclusion

- ***Not all factories are on the high level described:***
  - ROI for projects in the last years not always sufficient
  - Savings by reducing the number of factories higher
- ***Today new projects are started to reach the optimum energy consumption as described.***
  - Consolidation of European sugar factories at an advanced stage
  - Increase in fuel prices provides better ROI
- ***Measures to reduce the energy consumption introduced in the beet industry are also applicable for the can industry:***
  - One measure very often not sufficient

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Thank you
for
your attention

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Energy Efficient Beet Sugar Factories