No-Residue Treatment and Disposal of mixed, unsegregated Municipal Solid Waste "CombiTech" Combined Anaerobic Digestion and Gasification Technology with Conversion into Electricity

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Municipal Solid Waste (MSW) – a burden as well as a valuable resource for renewable energy, without emission of CO2

Treatment of unsegregated waste without source-segregation - a considerable cost reduction for municpalities and waste management companies.

„CombiTec“ combines two technologies:

- **BioTech = anaerobic digestion for the organic fraction and**
- **SRS (Selective Residue Solvolysis) = special gasification technology for treatment of plastics, wood and any kind of cellulose/lignin**

- for maximum energy efficiency and output

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CombiTech – The valuable Alternative

- Great variety of mixed input material (organics, plastics, wood, textiles, manure
- Treatment of wet, dirty, contaminated waste
- Use of mixed unsegregated municipal solid waste (MSW) without any pre-sorting.
- Apart from electricity generation of high quality compost fertiliser
- Conversion approx. 95% of MSW into energy, accordingly the problem of disposal of residues practically does not exist.
- Practically no residues, except a small mineral fraction (stones, broken glass, ceramics, etc.)
- Safe elimination of all toxic components such as halogens and heavy metals
- Recovery of all metals 100% including non ferrous metals. This guarantees considerable additional revenues!
- Treatment in closed tanks, so there are no environmental effects such as smell or water contamination

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Large Variety of Input Materials

- Organic household waste in various compositions
- Any type of organic material (food waste, residues from fruit pressings, olive oil treatment, straw, etc.)
- Any type of plastics (PE, PP, PVC, PET, PS, etc.)
- Any type of wood (trees, branches, chips, saw dust), even highly contaminated wood such as railway sleepers, old furniture, etc.
- Textiles, diapers, hides, rubber
- Paper, carton
- Sludge from settling tanks and waste water treatment facilities
- Slaughter house waste
- Hazardous/toxic wastes
- Hospital waste
- Electronic waste
- Waste from existing landfills, thus reducing their size and recovering valuable land
- Also residues from anaerobic digestion processes, if not saleable
- (digestate, compost)

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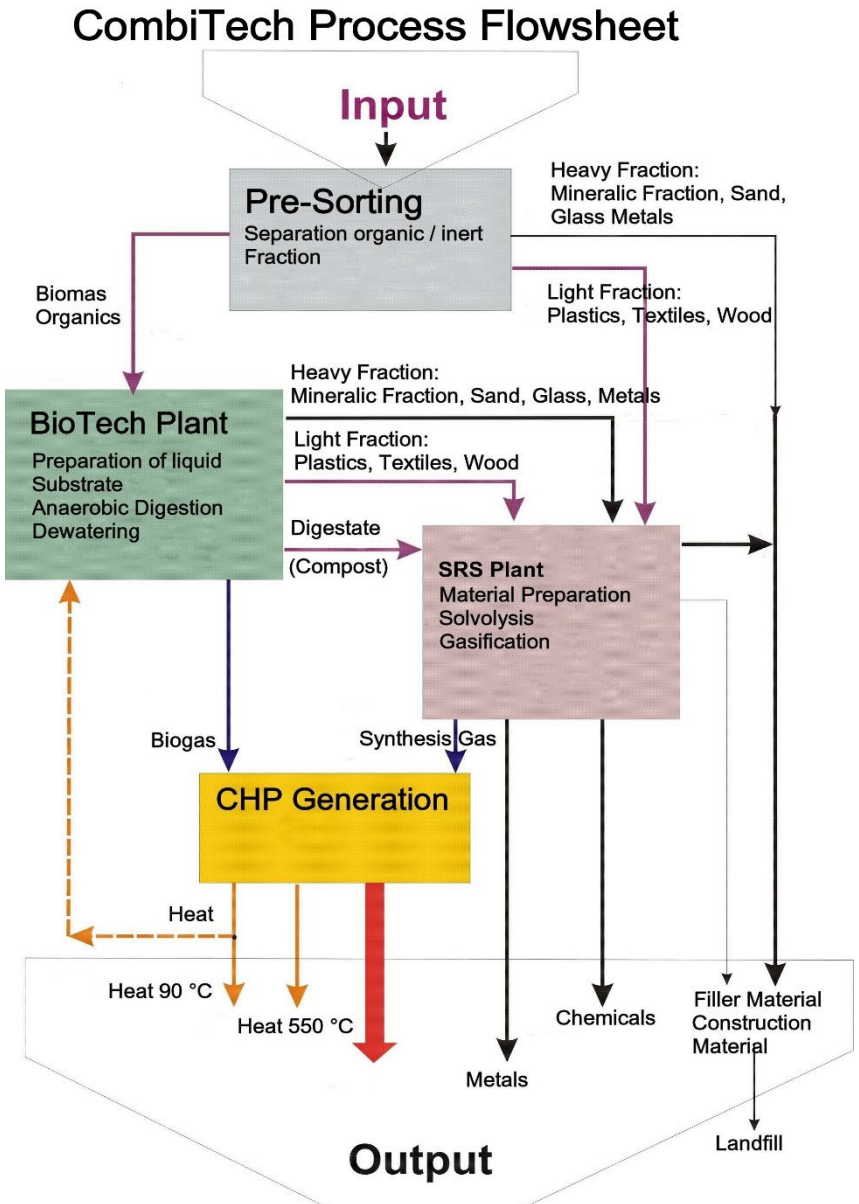
CombiTech – The valuable Alternative (cont‘d)



- **Safe elimination of all toxic/ hazardous components of the waste such as chlorine (Dioxine problematics), heavy metals, etc, so that the generated energy gas burns absolutely clean, without any hazard for the flue gases and subsequently for the environment, even without expensive and sophisticated filters.**
- **Very high conversion efficiency of over 80%. This is the reason for the high electricity generation which allows to operate CombiTech waste plants even with normal non-subsidised feed-in rates.**
- **Reasonable investment costs, approx 50 - 70% of incineration plants with similar specifications**

Products obtained from „First Stage“ BioTech Anaerobic Digestion Process

- Biogas is a combustible gas which consists 65 – 70% of pure methane, with a calorific value of 6.5 kWh per standard m^3 . This biogas is converted into energy but may also be used as a substitute for natural gas
- Compost generated by anaerobic digestion is a fully stabilised non-smelling soil substrate without any requirement for further aerobic after-composting. Its basic properties are:
  - compost still contains all the fertilising salts which the plants have absorbed during growth
  - compost has a high content of huminous acids which reactivate “dead“ soil, which has been overexploited by heavy chemical fertilising
  - Toxic matter like heavy metals etc. are approx. at 50% of permissible levels thus meeting easily EC or EPA US standards
  - compost assures a loose top soil with optimum soil aeration and water maintenance conditions

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Basic Process Stages

- Feeding of incoming waste into the „turbo dissolver“,
- Adding of water and heavy agitation, which disintegrates the organic fraction into a slurry, but does not affect the inert fraction
- Separation of the heavy fraction by sedimentation and the light fraction by screening, resulting in a purely organic slurry with less than 0,5% foreign particles
- “Hygenisation“ of the organic slurry for one hour at 70°C
- Anaerobic digestion of the organic slurry generating the biogas
- Separation and dewatering of the remaining compost fraction from the digested slurry
- Conversion of the biogas into electricity and heat in a standard CHP unit

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Process Fowsheet BioTech

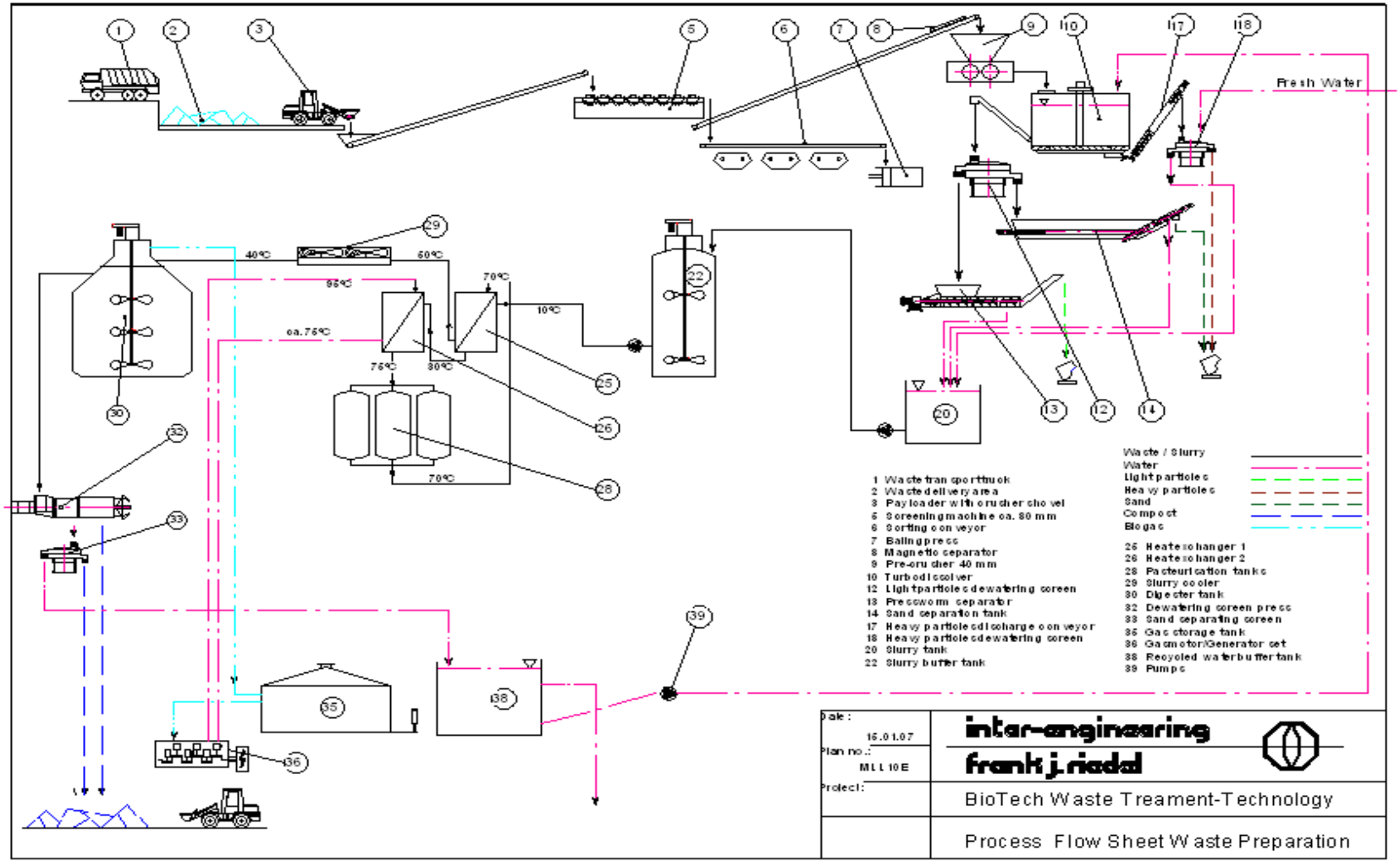

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Photo Demonstration

Input Material

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Photo Demonstration (cont‘d)

Photo Demonstration (cont‘d)

Photo Demonstration (cont'd)

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Photo Demonstration (cont'd)

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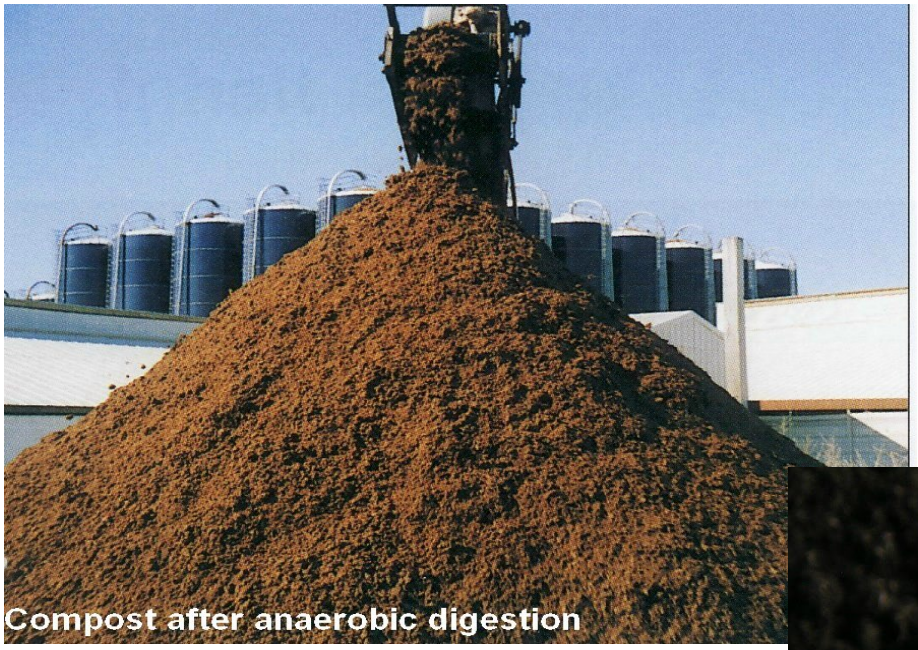
Compost after anaerobic digestion


residual waste compacted and dewatered


compost


heavy weight residual waste fraction

Photo Demonstration (cont'd)

Output from First Stage BioTech = Anaerobic Digestion

= Input into Second Stage
= SRS Gasification

SRS (Selective Residue Solvolysis) – the second Process Stage

- Anaerobic digestion cannot treat ligneous matter and plastics, but lignine and plastics contain the bulk of the energy!
- Accordingly the SRS stage increases energy output by 3 – 4 times!
- No-burn, no-emission technology
- > 80% energy conversion !
- Moderate process conditions (150 - 250 °C, depending of type of input material)
- Large variety of input materials, also wet, contaminated!
- Output in form of clean synthesis gas (CO + H2), free from tar, free from particles
- Safe elimination of toxic ingredients (halogens, heavy metals)
- Only mineral residues consisting of sand, silicates, broken glass, etc. and possibly certain insoluble (untoxic) salts (approx. 4-8%).

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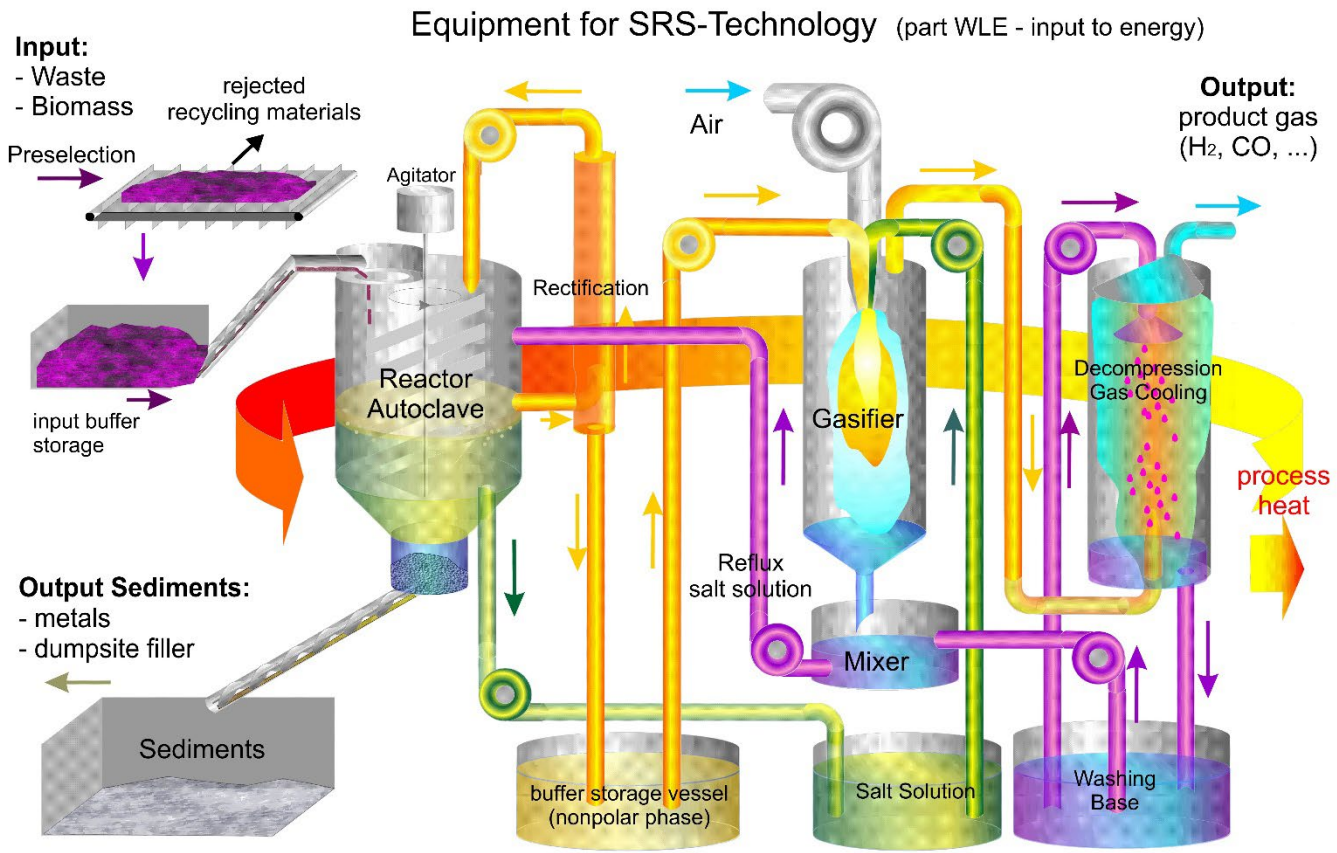
Basic Technological Features

- Preparation of input material by dissolving in a concentrated salt solution into an energy rich slurry
- Subsequent treatment in liquid form, which allows easy automation, material transport by pumping, no-burn technology
- Elimination of toxic ingredients with simple chemical buffering reactions from the liquid by adding specific additives
- Degrading of cellulose/lignin into compounds which do not contain any tar forming agents.
- No dust, no noise, no emissions
- Moderate process conditions (approx. 150 - 250 °C, 5 bar)
- Only three Process Stages consisting of:

- A) Liquefaction
- B) Gassification
- C) Conversion into electric energy

Process Description



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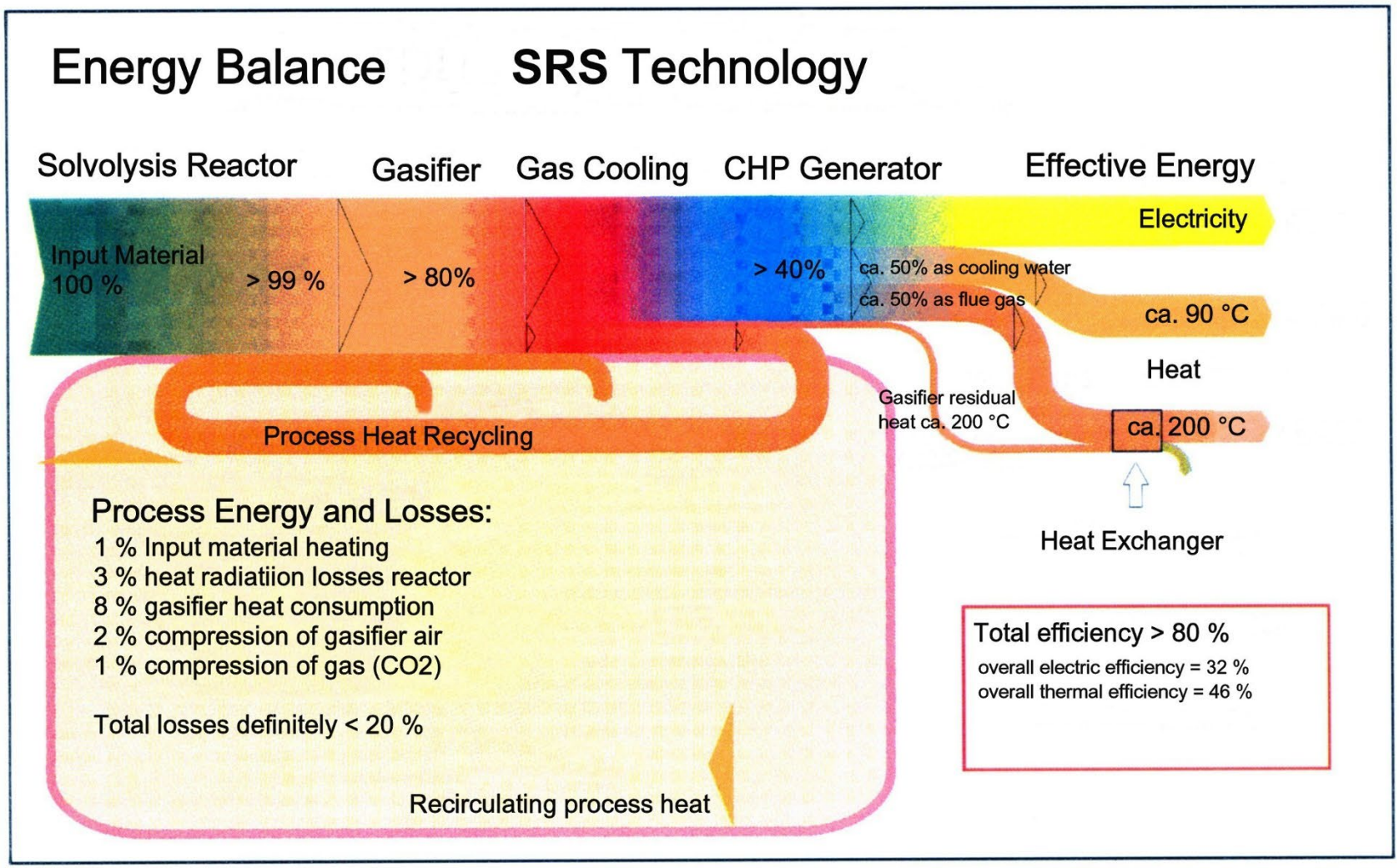
Energy Balance



Process Description (cont.d)

A) Liquefaction

- input materials are mixed into a concentrated and saturated salt solution
- A chemical reaction at approx. 200 °C loosens the bonding of the molecular structures, causing disintegration and dissolving
- Complex cellulose/lignin molecules are degraded into soluble organic salts
- Mineral (insoluble) particles sediment at the bottom of the reactor vessel
- If necessary special additives will buffer toxic elements such as chlorine, bromine, heavy metals etc. into insoluble compounds which are also eliminated by sedimentation
- 100 % elimination and recovery of all metals
- The remaining solution consists of an energy-rich watery solution of organic salts

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Process Description cont'd

B) Gassification

- **The liquid solution is pumped to a gassifier, resulting in a pure, tar-free synthesis gas (H2 + CO)**
- **Salts used for preparing the solution precipitate in form of a smelter along the walls of the gasifier, from where they will be recovered for reuse in the reactor (no consumable)**

C) Energy Conversion

- **The generated synthesis gas is decompressed and cooled down and taken to a CHP motor-generator-set**
- **Excess heat is available for the process itself, but also for external use with various options including conversion into cooling energy**

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Large Variety of possible Input Materials

Large Variety of possible Input Materials

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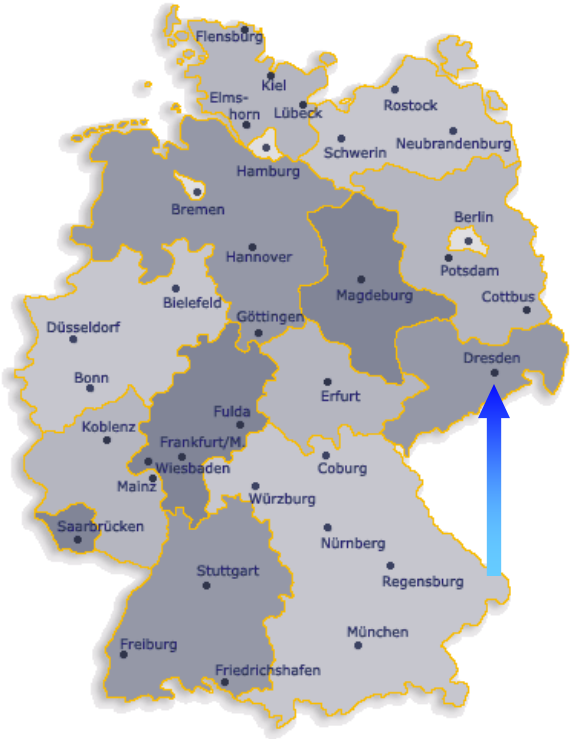

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