MOGUCNOSTI PRIMENE GASIFIKATORA UVUČENOG PROTOKA ZA PRERADU ČVRSTOG KOMUNALNOG OTPADA U REPUBLICI SRBIJI

Possibilities for Application of the Entrained Flow Gasifier for the Processing of Municipal Solid Waste in the Republic of Serbia

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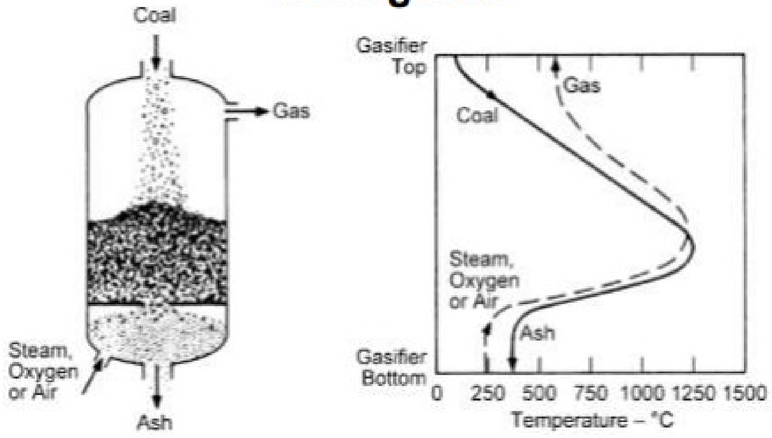
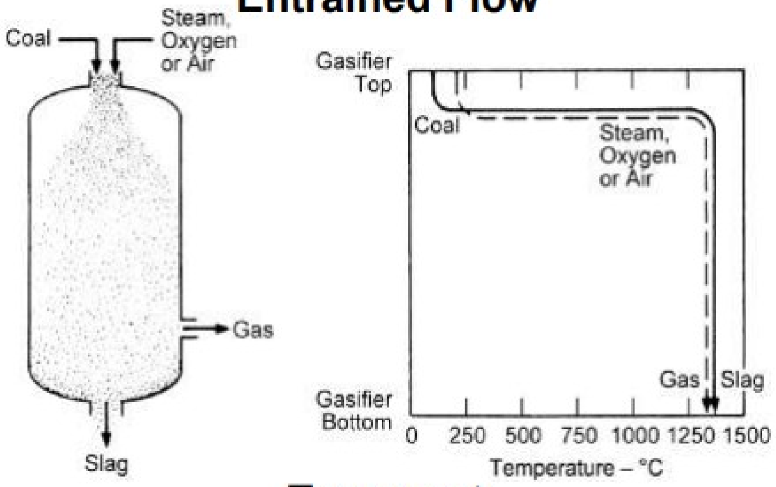
Gasifier Configurations

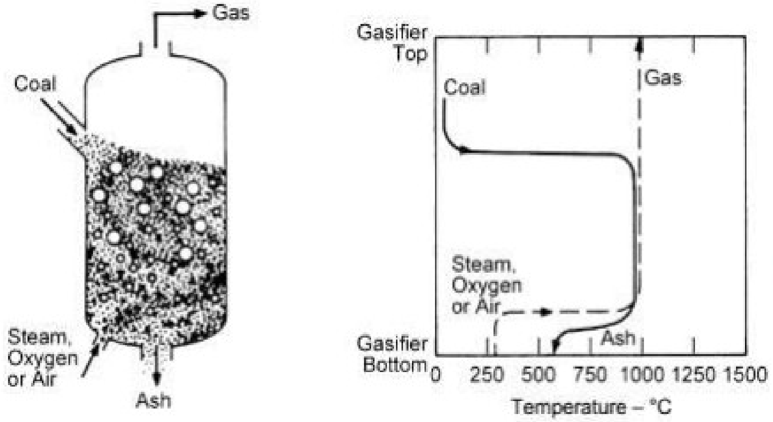
Moving Bed



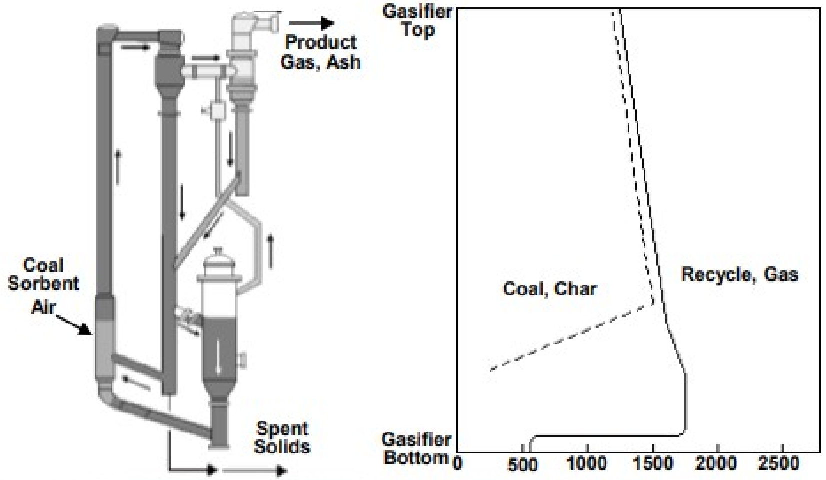
Entrained Flow



Fluidized Bed



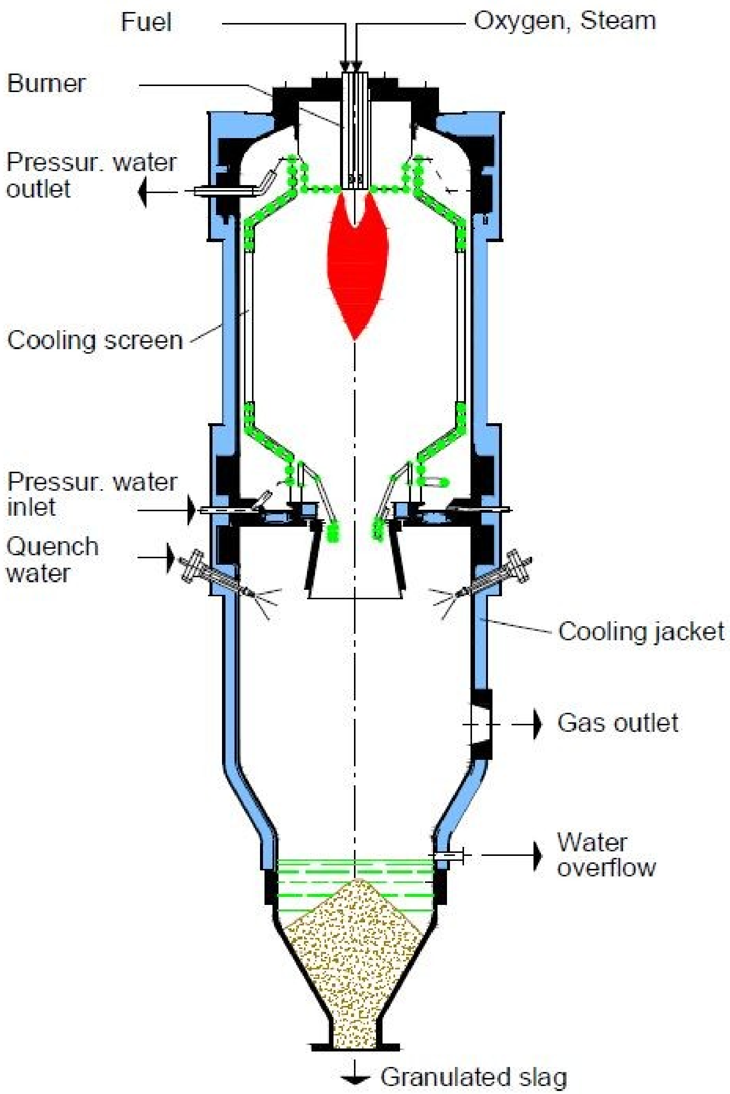
Transport



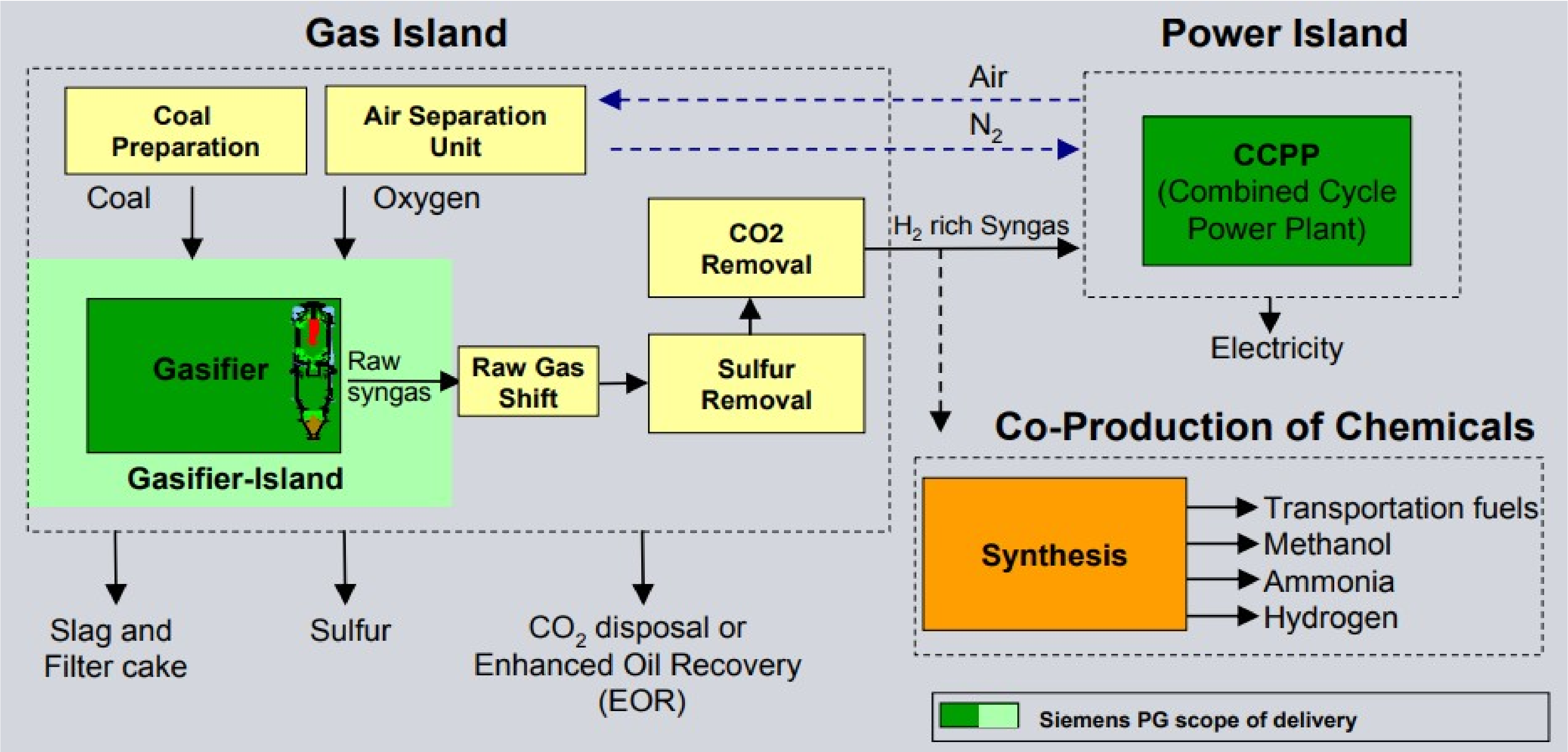
Siemens Gasifier

- The gasifier is a dry feed, oxygen-blown, top fired reactor with a water wall screen in the gasifier.
- It is able to convert a large range of fuels and is ideally suited for lower-rank fuels like lignite with high ash and moisture and other corresponding fuel types like biomass or liquid refinery residues.
- Particle size distribution and moisture level depend on the type of feedstock used; typical ranges are below 0.5 mm and 2-12 % moisture.
- Conversion takes place at temperatures of around 1,300°C to 1,800°C.
- These high temperatures, in combination with the dry feed system, allow for the almost complete conversion of the feedstock.
- The produced raw gas mainly consists of CO, H_2 and small amounts of CO_2 and is free of any higher hydrocarbons.

Siemens Gasifier



Siemens Gasification Combined Cycle



Specific Problems of MSW Processing

- An estimated composition. MSW is a complex mix of materials derived from a number of sources within urban areas, in turn destined for various handling, processing and disposal routes - MSW as a fuel can vary in type, format and relative quantity of components.
- MSW might include a number of composite materials and is likely to contain traces of hazardous elements (for example, lead, mercury, paints, pesticide, etc.) that could create operational and environmental risks.
- The percentage of biodegradable components (including organic ones), moisture and ash content directly influence both the energy value and the behaviour of MSW as fuel.

⇒*The composition of MSW for processing has to be constantly followed throughout the lifetime of the plant and the adjustments performed if required*

⇒*Some experience from the biomass gasification as the fairly mature technology could be utilised in designing MSW gasification*

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Incineration vs Gasification

Potential advantage/benefit of gasification vs. incineration	*Related drawbacks/issues that hinder the benefit of gasification*
(a) the combustible gas generated by gasification (gas) is easier to handle, meter andcontrol than MSW (b) the homogenous, gas-phase combustion of syngas can be carried out under conditions more favourable than those achievable with MSW	(a) since gas is highly toxic and explosive, its presence raises major security concerns and requires sophisticated control equipment (b) since feedstock is oxidized/converted in two steps (gasification + gas combustion/conversion) plants tend to be more complex and costly, more difficult to operate and maintain, less reliable
The reducing conditions in the gasifier: (i)improve the quality of solid residues, particularly metals (ii)reduce the generation of some pollutants (dioxins, furans and NO_X)	The actual production of pollutants depends on how gas is processed downstream of the gasifier; if gas is eventually The actual production of pollutants depends on how gas is processed downstream of the gasifier; if gas is eventually oxidized, dioxins, furans and N_{OX} may still be an issues
Gas can be used, after proper treatment, in highly efficient internally-fired cycles (gas turbines and combined cycles, Otto engines)	(a) Required gas treatment is costly and causes significant energy consumption/losses (b) Due to the consumption/losses of gasification and syngas clean-up, overall energy conversion efficiency is typically lower than that of combustion plants (c) At the small scale typical of waste treatment plants, efficiency of internally-fired systems is low (especially if gas turbine based)
Gas can be used, after proper treatment, to generate high-quality fuels (diesel fuel, gasoline or hydrogen) or chemicals	(a) Required gas treatment very demanding and costly (b) At the small scale typical of waste treatment plants, synthesizing quality fuels or chemicals can entail prohibitive costs
Gasification at high pressure enhances the opportunities to increase energy conversion efficiency and reduce costs	Pressurized waste gasification poses formidable challenges and has not been attempted by any technology developer

Application of Entrained Flow Gasifier for MSW Processing

- It is necessary to study the optimal parameters, such as type of gasification agents and its flow rate, and temperature, for the thermal treatment of MSW and its composites, such as wood, plastics, as a feedstock to derive the maximum possible energy.
- The design of the plant should provide reliable and commercially viable operation.

Initial step for the selection of the technology is the calculation of gross revenue in order to estimate the viability of such projects

As the practical example was used the region of Niš, Serbia, with the following parameters:

- ➢Waste composition as published in 2015
- ➢Nominal MSW quantity for calculations 100000 t/year
- ➢Plant operation based on assumed 330 working days per year on 24 working hours basis

Average solid waste composition for the region of Niš, Serbia

MSW composition:	%	t/year	%	t/year	t/day	t/h
			dry matter	dry matter	dry matter	dry matter
Organics	31.2	31200	35	10920	33.1	1.38
Paper, Cardboard	13.39	13390	50	6695	20.3	0.85
Wood			70			
Plastics	31.86	31860	95	30267	91.7	3.82
Rubber, leather, textiles, diapers	7.33	7330	80	5864	17.8	0.74
Metals	1.62	1620	100	1620	4.9	0.2
Glass	5.6	5600	100	5600	17	0.71
Stones, sand, ceramics	9	9000	80	7200	21.8	0.91
TOTAL	100	100000				

MSW input for gasification

	t/year	t/day	t/h
Organic fraction	10920	33.1	1.38
Paper/cardboard	6695	20.3	0.85
Plastics	30267	91.7	3.82
Rubber, rags, leather, diapers	5864	17.8	0.74
TOTAL	53746	163	6.79

Energy content of MSW components

	Selected MSW component t/day	Specific energy content kWh/t dry	Available energy content kWh/day
Organic fraction	33.1	3500	115,850
Paper/cardboard	20.3	3800	77,140
Plastics	91.7	9100	834,470
Rubber, rags, leather, diapers, etc.	17.8	4100	72,980
TOTAL	143,3	-	1,100,440

Gross electrical and thermal energy production

	Units	Quantity
Electrical energy		
Energy content of syngas	kWh/day	1,100,440
Overall process conversion efficiency	%	80
Total energy generated	kWh/day	880,352
Conversion into electricity	%	42
Produced electric energy	kWh/day	369,748
Thermal energy		
Remaining thermal energy	kWh/day	730,692

Conclusions

- Entrained flow gasification should be taken into consideration for the conversion of non-recyclable MSW components into energy, in particular within combined heat and power (CHP) plant.
- Siemens' proprietary solution was presented as a specific example for several reasons, including their long experience and practical applications, high carbon conversion coefficient, syngas purification, their own solution for Integrated Gasification Combined Cycle (IGCC), etc. Hence, such well tested and documented system provides a sound basis to adapt to MSW as feedstock.
- The specific requirements for MSW gasification point out that perhaps the most critical segment in the process is the fuel feeding system. The starting working platform might be the industrial gasification of biomass in use in entrained flow gasifiers, further adjusted to MSW composition on a case-by-case basis.
- The provided yield and gross revenue analysis, based on the average MSW composition for the region of Niš in the Republic of Serbia, shows the potential of entrained flow gasification. With the assumed round figure of 100000 t/year of MSW for processing, the example can be easily adjusted to another location, i.e. quantity and/or composition.


thank you
danke
謝謝
ngiyabonga
teşekkür ederim
gracias
merci
obrigado
dziękuję
bedankt
спасибо
рахмат
Баярлалаа
sukriya
kop khun krap
go raibh maith agat
mochchakkeram
arigatô
dakujem
grazie
terima kasih
감사합니다
ありがとう
мерси
хвала
tapadh leat
dank je
takk
taiku
sagolun
hvala
mauruuru
koszonom
faafetai lava
vinaka
blagodaram
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