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Syngas Desulfurization following Microwave Cycled Gas Bubbling on Coal and Biomass Pyrolysis

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I. İntroduction

In this study, the significant reforming tests for pyrolysis coal and wood tar mix have been made on low iron poor zinc ores containing PbO, ZnO, Fe2O3 inclusions as granules controlled with coal and biomass char/tar feed in order to reach catalytic reforming at 700 C providing heat transfer in microwave radiated cell to sequent column reactor. However, the results of filled bed poor iron slime yielded high heat transfer to coal and biomass char and tar. Due to the complex chemistry of coal, and porosity, heat conduction decreased in the microwave radiated cell system by granule size decrease. The iron slime conductivity distribution was raised temperature in the microwave activation dependent on the microwave heating power.
Heated iron slime granules in microwave radiation cell provided high heat conduction solid tar mixing gas flows. The gas flowed through sequent column are cycled for reforming hydrogen rich gas. one of the most promising technologies for advanced thermal energy conduction and radiation managed by microwave irony slime heating under microwave radiation favorable economic potential and intrinsic parameters.

II. Microwave Pyrolysis and Desulfurization

There are various objectives to make the necessary arrangements to increase the use of biomass and solar energy as the other device. Considering the known biomass area of the potential high forest fields in northern Anatolia and located in central and eastern Anatolia.(Karayilmazlar et al.2015) it is seen as having low to medium heat resources. As we have seen in our country there is a significant potential for biomass resources will be invested. The low heat waste will be great source for waste heat and in comparison the electricity production may reach on 60-70 % thermal performances by microwave co-combustion.(Gürel 2020)
In conventional thermal processing, energy is transferred to the material through convection, conduction, and radiation of heat from the surfaces of the material. In contrast, microwave energy is delivered directly to materials through molecular interaction with the electromagnetic field. (Jian 2015) In conventional methods, energy is transferred due to thermal gradients, but microwave heating is the conversion transfer of electromagnetic energy to thermal energy through direct interaction of the incident radiation with the molecules of the target material.(Anietie et al.,2022)

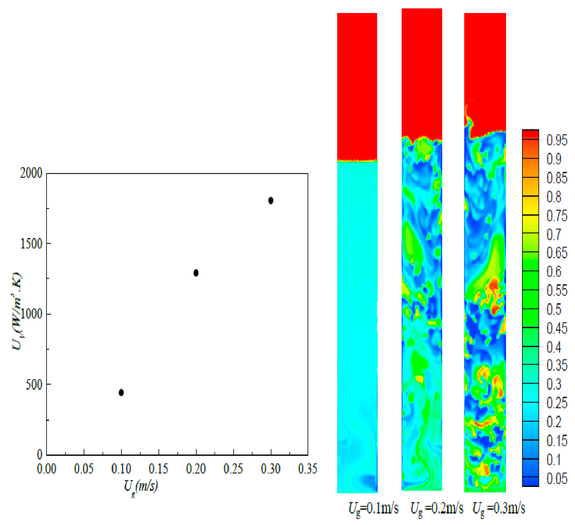

Fig. 3. Volumetric heat transfer coefficient (U_V) versus U_g

Fig. 4. Gas volume fraction contour at different U_g

III. Method

The porous structure of activated carbon and molten salt s a factor that determines to a great extent both the rate and degree of reduction (Tosun, 2018). Sharma et al. (2008) found that, a mesoporous coal was more efficiently rdesulfurized gaseous tar more than a microporous coal.
Phenol molecules that may undergo an oxidative coupling reaction may be irreversibly adsorbed on coal, which in turn may result in low carbonization efficiency. Phenoxy radicals formed by the removal of a hydrogen atom from each phenolic molecule can participate in direct coupling with other phenoxy radicals at even room temperature, coal surface serving as a catalyst.

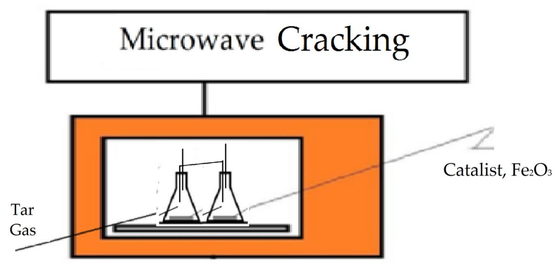

Figure 1. Desulfurization experiments using Microwave oven

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Table 1. Desulfurization materials and salts using Microwave oven and results

material name	the chemical composition and the bulk density of materials
the calcium ferrite pellet	CaO:21-28%; SiO2≤10%;Fe2O3:35~45%;Al2O3≤6%;MgO≤4%; P≤0.1%;S≤0.1%, the bulk density:2.8~3.2g/cm3
the sintered ore	CaO:9.16%; SiO2:5.18%;TFe:54.3%;P:0.05%; S:0.02%
iron oxide powder（cold rolling iron skin）	The content of total iron is 55%
the iron scale	The content of total iron, silica and water is respectively 70.02%, 1.55% and 8.5%.
lime powder	CaO≥90%

Materials	C	H	O	S	N	Total Desulfurization rate
Coal, Şırnak Asphaltite	22	5	15	7	2	42
Biomass, Oak wood straw	30	19	45	0,5	4	87
75%Biomass Tar	75	7	12	1		97
50%Biomass Tar	65	7	10	2		93

Conclusions

In modified pipe microwave reactor, where the average concentration of solids amounts to 10 - 50 g/m^3, i.e. the conditions for residence time are long enough for the thermal cracking of biomass tar and coal tar and extensive gas mixing with 60-70% N2 and air so enhancing biomass pyrolysis and tar feeding inlet in order to take the down draft gas, heat transfers to the microwave cracking section. It is necessary to create conditions of internal circulation without the transported coal and waste in modified pipe and downdraft gasified, 90-95% tar yield were observed at the end of combustion.

References

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