Scale-up applicator for microwave plasma gasification

Preferred Presentation Format (please select one):

Visual

Keywords (maximum of three):

1. Microwave plasma
2. Advanced gasification
3. Scale-up

Topic & Subtopic:

4. Biomass conversion for bioenergy

4.4 Gasification for synthesis gas production

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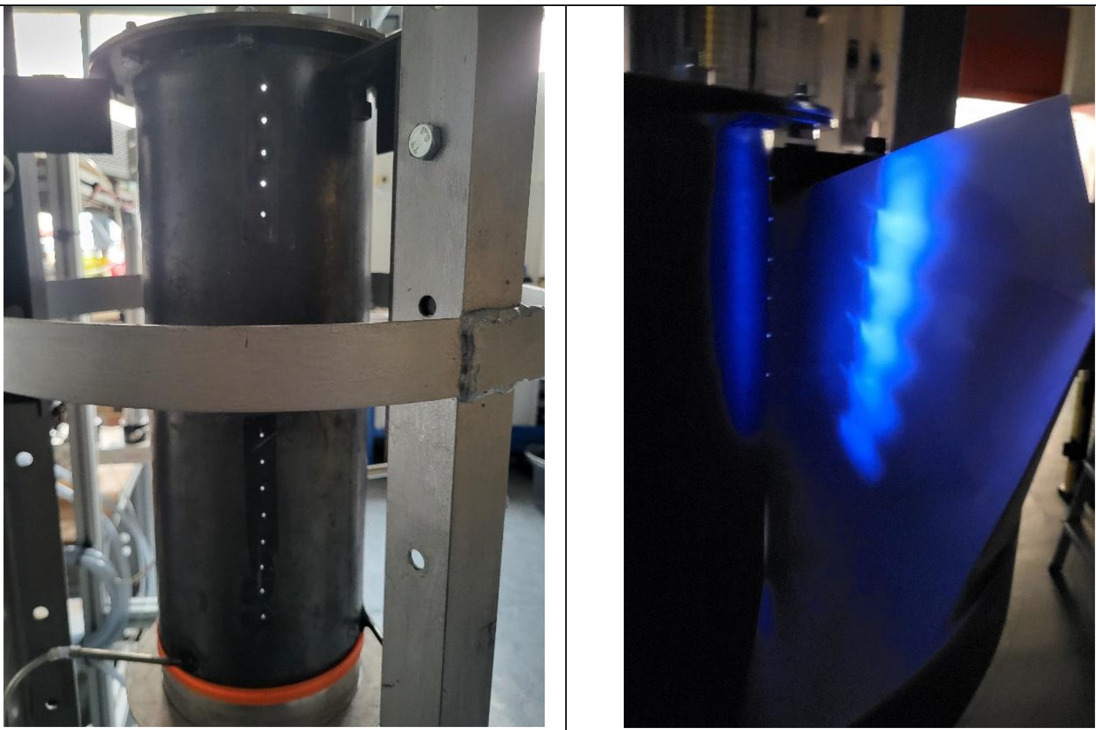
ABSTRACT SUMMARY

Microwave (MW) plasma gasification has been discussed as a promising technology, due to opportunities for increased efficiency whilst eliminating the use of catalysts. Energy consumption compared to arc plasmas is less. MW plasma gasification has fast start-up and shutdown capabilities providing flexibility over conventional technologies. Currently, a major barrier to the widespread application of MW plasma technology is the difficulty in scaling up the reactor as the torches in use are small and are constructed with fragile ceramics. Generally, fused silica and alumina ceramics have been used to make applicators with inner diameters in the range of 25-30 mm when operating at 2.45 GHz (lab scale) or up to 65-80 mm when operating at 915 MHz (industry scale).

In the first stage of our project, a new design of the applicator has been made, and preliminary experiments have demonstrated that relatively stable MW plasma can be generated in a metallic plasma chamber (no ceramics). The inner diameter was near to 180 mm (as shown in the photographs) and the frequency was 2.45 GHz. Our success opens a window of opportunity for increasing the capacity of MW gasification processes, as well as readily allowing the feed of fine solids directly into the plasma zone.



a) Plasma chamber, ID 180 mm b) Image of plasma through pin holes

APPLICABLE TOPIC AND SUB-TOPIC NUMBER

The main target of the project is to develop a new applicator for microwave plasma to increase the capacity and efficiency of the gasification process for the production of syngas from solid feedstocks. Thus, it is suitable for the subtopic 4.4 Gasification for synthesis gas production.

AIM AND APPROACH

This research hypothesises that microwave plasma gasification at atmospheric pressure can be performed more efficiently, with extended equipment lifespan and at a significantly larger scale of furnace, when the plasma is excited. Based on theory and simulation results, different types of plasma chambers have been developed and tested.

SCIENTIFIC INNOVATION AND RELEVANCE

The innovation is to develop a plasma furnace without the requirement of lining, and the walls are manufactured from a corrosion-resistant metal, such as stainless steel.

Scaling from laboratory operation at 2.45 GHz to industrial scale at 915 MHz by increasing the physical dimensions is not expected to change key plasma properties, provided power is also scaled. A vessel diameter that was 180 mm scales to 481 mm at 915 MHz, hence the area increases by a factor of 7.2. As the plasma might also extend in length depending on the power supplied, the feedstock rate is expected to increase by a factor of 7 or greater. Current tests utilise about 4.5 kW of MW power, hence for industrial scale, the requirement increases to 30kW or above.

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