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Application of Confined Plunging Liquid Jet Reactor (CPLJR) as an aeration and brine dispenser technique for the environmental safe discharge of brine from Kuwait's desalination plants

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More than 90% of Kuwait's freshwater needs are met by desalination with a cumulative production of 2.1 million cubic meters per day. The desalination plants located along the northern and southern coasts discharge brine directly into the highly biodiverse coastal waters. A continuous long-term discharge may change the chemical and physical characteristics of the receiving water body. Incorporation of the novel CPLJR for the discharge is an ideal way to mitigate these environmental impacts by enhancing the dissolved oxygen dissolution, mixing and dilution rate. The CPLJR reactor possesses many advantages over conventional methods, such as: 1. Brings two phases in contact and achieves high mass transfer rate by entraining gas bubbles into liquid; 2. Improves gas absorption rates by increasing the contact time between the gas bubbles and the water aided by increasing the jet penetration depth and creating a fine dispersion of bubbles; 3. Increases the gas-liquid contact surface through reducing primary bubble coalescence into secondary ones; 4. Efficient mixing; 5. Relatively low power inputs; 6. Low operating costs. Gas-liquid reactors are employed in a variety of processes, such as reaction in the chemical industry, wastewater treatment, air pollution abatement and fermentation. It consists of a vertical tube that is partially immersed in the liquid pool. The top end of the tube is connected to a nozzle, whilst the other end (bottom) is left open to the receiving liquid pool, known as confining tube (down comer). CPLJR improves the gas mass transfer rate into liquid by increasing the jet penetration depth and contact time between the gas and liquid and increasing the gas – liquid contact through hindering or reducing primary bubbles coalescence into secondary ones. The current work deals with the investigation of air entrainment performance of the novel CPLJR with different geometrics and also deals to determine the effects of the jet velocity, jet length, nozzle diameter, and down comer diameter on the volumetric rate of gas entrainment. The entrainment rate increased with an increase in jet velocity, jet length, down comer depth, nozzle diameter. The entrainment rate increased by about 40-50% with a two fold increase in jet length.

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New conception of ground turbines based on rotating detonation combustor

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Detonation is a type of combustion involving a shock front and a coupled exothermic front, with a high temperature and pressure gain. A rotating detonation combustor (RDC), one of detonation-based combustors, constrains rotating detonation waves in a cylindrical annual combustor, has three outstanding advantages: A theoretical thermal efficiency about 50% higher than the Brayton cycle, a considerable emission reduction of CO_2 and NOx, and no moving parts. Due to those advantages, the rotating detonation combustion has become a research hotspot recently. Based on our work of rotating detonation, we look at its application in the energy field and first put forward the new concept of ground turbines based on RDC. The new ground turbine consists of compressors, turbines and the RDC, in place of traditional isobaric combustor. Thanks to the high pressure gain, compressors stage may be reduced to single (or far less stages), so does the turbines stage. A thermodynamics analysis of the rotating detonation was adopted to determine key parameters of ground turbines. We carried out amounts of experimental and numerical researches with RDE, to study the fundamental technique and characteristics of RDC, which are significant to the ground turbine. Moreover, a prototype of rotating detonation turbine engine has been built and tested in experiment to prove the feasibility of the concept. The ground turbine based on RDC shows great advantages on the thermal efficiency, emission reduction and manufacturing cost, which indicate its practical value in the future. We studied its basic characteristics and proved the concept by experimental means. Next, we will continue with the technical details and consider engineering issues.

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