THERMOGENICS, INC

Energetic innovation in energy conversion

Water's role in Gasification

The *Watrex* Processes

Water is crucial to gasification and the optimum use of it has a pronounced benefit to the overall efficiency and success. The basic gasification reaction of $C+H_2O->CO+H_2$ is not always used effectively and in larger scale coal gasifiers is vital to the reaction from the lack of incipient water in coal, it has to be added either as steam or liquid.

Carbon will form, for lack of better definition, a boundary layer around itself that prevents the oxygen alone from reacting with the carbon, but water penetrates this boundary layer and causes accelerated reaction, increasing the throughput rate of a properly designed gasifier. Cellulosic materials may have to have water added to the process to bring this effect in spite of it's inherent content.

Additionally, water is produced in gasification reaction as any combustion reaction will produce water as a by-product. Management of this produced water is critical to the economic and environmental success and coal gasification plants have a significant cost in the water treatment and disposal or conversion of the wastes to acceptable standards. Some third world gasifiers dump the produced water into open pits that is clearly not acceptable as it contains a wide variety of organics that are long-lived and toxic to the environment.

Many biomass gasifiers will feed the gas to an engine at 140F or so, a temperature that will reduce the condensed water production, and is a notably difficult process to handle the disposal of it with such language as "We don't want to drop the temperature as it produces water", but dumps the water and accompanying organic compounds into the engine such as acetic acid, methyl alcohol, methyl ethyl ketone and others that when combusted form acids that attack the bearings and other metals shortening the lifetime of the engine. Water content in the gas reduces its heating value and volumetric efficiency of the engine. By removing the water and its corrosive components, engine efficiency and lifetime are benefited.

To appropriately address the produced water issue, most systems will use a complex series of processes, particularly in coal systems, to remove these components and convert the produced water into manageable products that can be either disposed of or re-used in the process. These steps are complex and can be expensive, contributing significant cost to the overall process.

Thermogenics has created a unique series of steps that use effects not typically used in the gasification field but are effective and through a wide range of experiments has simplified the process necessary to manage gasifier produced water with minimal cost both in capital and operating cost.

The first process is to separate the tars from the water base that is compact and effective. Tars can clog any valve, piping, pump, or other liquid handling process and make the simplest process such as level control difficult. A unique method has been developed to do this that allows down stream water processing without tar clogging.

The second stage is to use Van DerWaal's force to remove primarily the suspended solids from the water and in doing so, they spontaneously coagulate and precipitate.

The third stage is to further remove organic contaminants to the point where simpler methods can be used for final processing, even to boiler or potable water. This process has been used in other

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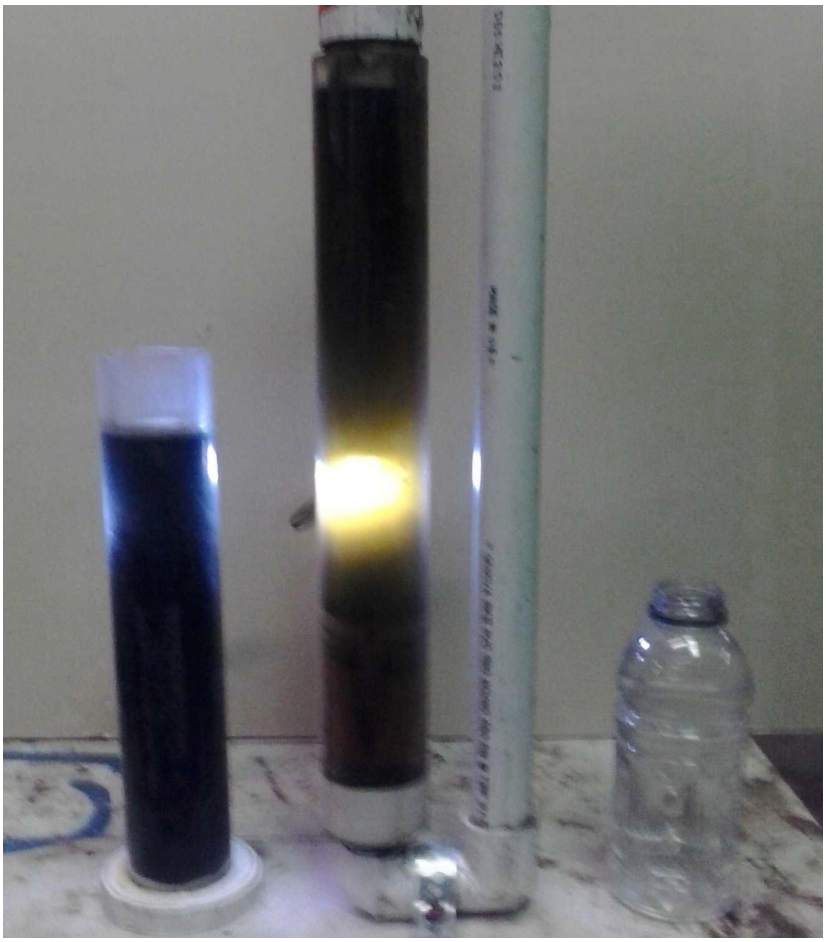
applications but not in produced water treatment as can be determined from evaluation of the processes available in the literature.

All of the above procedures are passive, minimally energy and consumable consumptive and very little interaction from operators. Alarms and automation are part of the control of the process.



This photo shows the various stages of TOW cleaning after the initial tar removal process. There is identical backlighting to show the lowered opacity of the solution. The incoming water is highly contaminated with organics and after the first stage, the organics are coagulated and precipitate. The third bottle of water is after the total process and although not potable, can be upgraded to potable or boiler grade feed water necessary for steam production used in carbon conversion and temperature control. .

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