INTRODUCTION TO DE-CARBONIZATION AND ENERGY EFFICIENCY TECHNOLOGY

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REFORMING BITUMEN FROTH DEAERATION PROCESS

Project Description:

The proposed project/technology involves revamping the traditional froth deaeration process to minimize steam consumption. It will help achieve the downstream specifications of de-aeration and thermal heating.

The current surface mining oilsands extraction process utilizes the froth deaerator to reduce the air content of the bitumen froth to make it pumpable and achieve specifications required for further processing. The current set-up is in operation since its inception and meets the process requirements; however, this existing set-up consumes significant steam resulting in significant GHG emissions.

Technology:

The proposed technology (will be disclosed as per request from the interested client) integrates the latest technologies to fulfill operations objectives.

The proposed technology will help in limiting steam consumption, which translates into a significant reduction of steam consumption and therefore, GHG emission. It will also meet the specifications for the pumping and thermal heat gain.

However, to implement the proposed process, it may need to revamp the current configuration.

There is no additional power requirement anticipated, as the required power for the new process is assumed to be offset within revamping.

It is to be noted that the proposed process is different from the static deaeration process.

Opportunity:

This process can be easily proved at a laboratory scale. This technology, when implemented will offer significant cost benefits.

It is imperative that this technology or other alternate technology if available shall be deployed to replace the existing steam based deaeration process to reduce the GHG emission.

Environmental Benefits:

Dramatic reduction in GHG emission as steam consumption goes down.

Area of application:

- *Bitumen Froth Deaerator – Extraction plant, minable Oilsands*

1. Innovation Opportunity

Referred to Fig. 1, the bitumen froth is heated and deaerated within an alternate simplified deaeration vessel design incorporating a cluster of heated tube decks.

Referred to Fig. 2, shows modified general arrangements replacing the existing shearing assembly within the existing Deaeration vessel. The Deaeration vessel dimensions and other design conditions remain the same however this invention discovers an alternate way of achieving the bitumen froth deaeration by replacing and redesigning the internal mechanical shearing assembly.

Heat and material balance is simple based on heat duty and presented within GHG Benefits, “example” section.

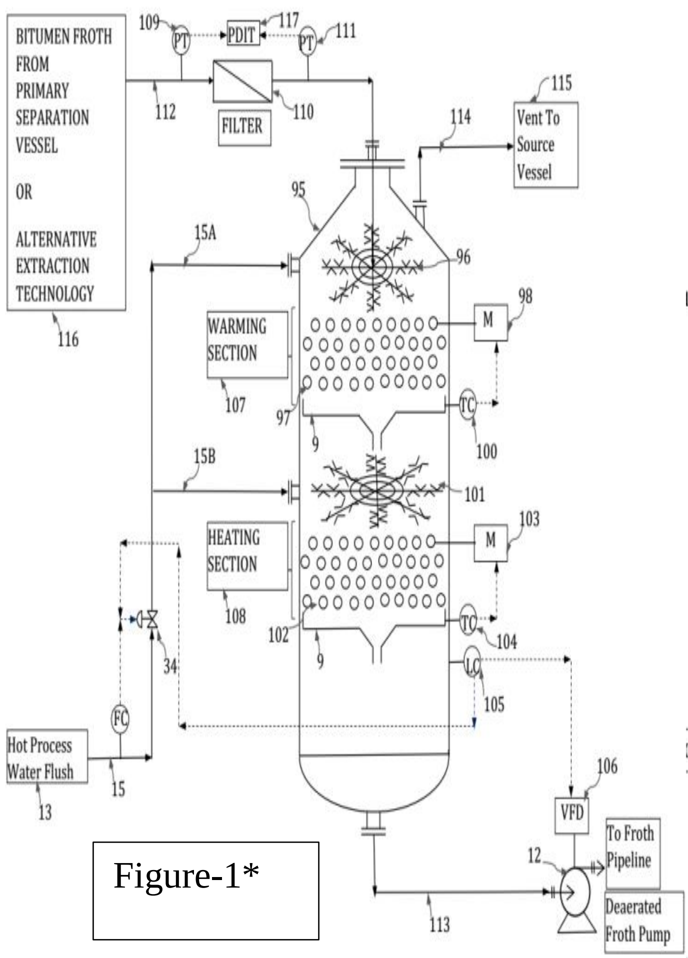

Figure-1*

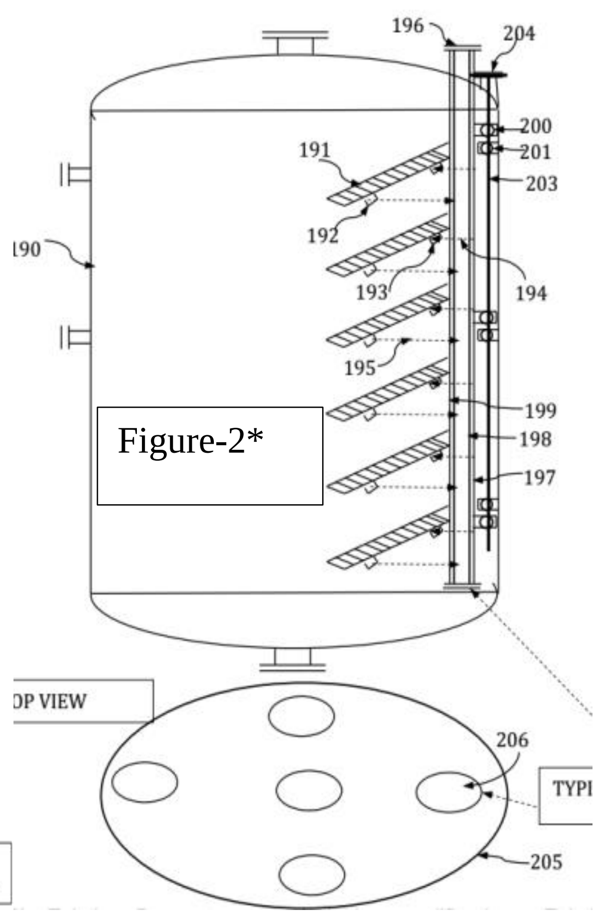

Figure-2*

* - Patent Under Progress.

FIGURE-1: The froth from the primary separation vessel is filtered and introduced within the froth Deaerator. The froth deaeration vessel contains a plurality of nozzles to accommodate heating and deaeration assembly, instrumentations, and other feed and discharge nozzle connections.

The deaerator vessel design as incorporated is a vertically oriented cylindrical shell which encompasses the two decks of heating elements located at the top and middle of the vessel. Each heating deck is provided with a feed distributor upstream. The feed distributor is designed to distribute the feed evenly throughout the top surface of the heating element. The feed distributor can be designed as a spiral ring with multiple legs extended throughout the diameter. The Deaerator design comprised of three sections. The top section is termed as a "warming section" based on the temperature specifications, which include a feed distributor, a deck of tubes encompassing heating elements, and a collection tray with a funnel at the bottom of the deck. The middle section is termed as "heating section" based on the temperature specifications, which again includes a feed distributor, a deck of pipes encompassing heating element, and a collection tray with funnel for the liquid collection. The bottom section is a typical liquid collection or a buffer zone to accommodate the pumping of the deaerated froth. The Deaerator is designed to accommodate operations under a mild vacuum to generate flash steam, remove free air and increase shearing between liquid froth curtain and upward flowing air stream. The heating element is designed such that it occupies the maximum area within the sheathing and ensures equal distribution of heat throughout the core.

FIGURE-2: Shows the completely new modified mechanical arrangement for the Deaeration vessel with the 4 to 6 standpipes and associated mechanical shearing assembly. The arrangement shown is typical for the rest of the sections and ensures that the total wetted area available coincides with the calculated total surface area required for the effective bitumen froth deaeration. However, it is not necessary to redesign completely the mechanical shearing assembly as long as the existing structure accommodates the replacement of the wetted material with an alloy-based resistance heating material and access to the control and electric power supply cables and other auxiliaries as shown in figure 2 for the electrification of the process. Since the wetted area and therefore the total surface area remains the same however the existing material of construction for this piece of material changes to the alloy-based material which is commercially available for high-efficiency resistance heating. The typical general arrangement as depicted represents the modifications/changes required with the existing mechanical shearing assembly structure or the minimum considerations while designing the completely new mechanical shearing assembly structure. The shearing plate is facilitated with lugs connected to power supply cables and a resistance temperature detector with a control cable. The connection lugs for the power supply and the RTDs are located at the back side of the shearing plate to prevent direct contact with the liquid, however, the location of the lugs connections and necessary protection to avoid exposure to the process shall be according to the manufacturer or vendor recommendations or shall follow the best engineering practices or the latest technology available commercially. This Electrical power supply cables and lugs and the Resistance Temperature Detector and control cable are typical for all the wetted sharing plates. The standpipe has separate cable trays for the power supply cables and for the control cables which carry cables to the top of the Deaerator vessel and through the head of the vessel where junction boxes are provided to connect with the cables laid out to the PLC or DCS.

-The technology is developed to solve the problem- known as GHG and water conservation.
The current practices employ the Low Pressure Steam for the bitumen froth deaeration process. The main drawback is actually associated with usage of the steam. The Bitumen Froth Deaeration process requires significant quantity of the steam which is ultimately diluted with the main process stream and therefore causes loss of the condensate which apparently ends up as a produced/ tailings water.

This process also uses additional treated water in the terms of de-superheating medium, which also ends up as a dilution with the main process. Also, the steam condensate disposed of the steam traps during transportation is not recovered which adds up energy and water losses.

The steam assisted deaeration process is a traditional process which was developed decades ago and still practiced widely. The reason being that, the industry tried to find alternate solution, however unfortunately the steam assisted process is still under practice.

The proposed technology provides transformative improvement by discontinuing use of the steam as a heating medium and replacing with electrified heating approach. This firstly, eliminates the water losses (in terms of steam condensate and de-superheating medium) and reduces GHG footprint with usage of renewable electricity for achieving the deaeration objectives.

There is no known competitor exist in the market who is actively working to find a solution to the given problem. Operating companies themselves were working on this problem for last decade and have tried many alternatives technologies on pilot scale (and patented those technologies) however, they were seldom commercialized. Many Oilsands operators are still employing Low Pressure Steam assisted froth deaeration process which over the course of the time may prove uneconomical.

The industry have tried to develop a static deaeration process which does not use either steam or electricity for achieving deaeration objectives however, never heard that it have made the way to the commercialization stage. In contrast the proposed technology recommends electrification of the unit with renewable green electricity for the elimination of the emissions and significant water conservation.

- The very first thing which makes it novel an innovative is conceptualizing process of electrification and designing a mechanical arrangement which can be practically commercialized.
- The aspect of solution which makes it novel is that the proposed technology can be deployed either in-plant or remotely in-pit locations where steam is not available.
- The prosed technology will allow the facility to use renewable energy for achieving deaeration operation which will result into reduced GHG footprint and significant reduction in water consumption.
- It is novel in its kind of as no such solution is yet implemented by industry.

The project is at conceptual and design development stage. The next step towards the commercialization would be pilot plant set up, testing, validation, data collection and safety and reliability analysis. It will also include the carbon emission accounting and cost-benefit analysis.

Upon successful completion of laboratory or facility based pilot evaluation, the engineering design and procurement can be performed further for the commercialization of the project.

The requested funding from the ERA will help in performing preliminary engineering work and setting up pilot scale facility and construction to accommodate testing and mitigate other expenses.

2. Project Implementation Plan

The objectives of the project are to set-up a pilot scale facility for testing and validation of the proposed technology and claimed benefits.
Project scope includes preliminary studies as outlined below, Design development and engineering work and involvement of procurement and construction for the successful set-up of the pilot plant.

- Conceptual study, Feasibility study, Cost benefit analysis, Emission reduction and accounting analysis, risk management workshops, etc.

- Engineering deliverables such as process simulation, heat and material balance, project design criteria, process control documentation, process flow diagrams, process and instrumentation diagrams, equipment design specifications, equipment datasheets, line lists, process calculations, control and shutdown narratives, risk and process safety assessment, electrical load analysis, utility summary, etc.

3. GHG Benefits

- The proposed solution leading to the electrification of the existing operations. The electrification is usually possesses higher GHG potential. However, electrification would lead to GHG emission reduction by deployment of energy sourced from the renewable resources.
- For the comprehensive GHG estimates associated with the Bitumen Deaeration Process, each and every element of the process would need to be evaluated and then the final conclusion can be drawn. However, what is obvious is that with the electrification of the process and especially sourcing electricity from the renewable sources (completely or in proportion) would definitely lead toward the net-zero solution.
- The realistic time frame of achieving net-zero solution is anticipated at an immediate basis, subject to the industry deploys the renewable energy at work. The time line does not extend to 2030 or beyond that until 2050; rather the benefits could be realized upon implementation of this technology.

GHG Estimations:

Referred to the Department of Energy (DOE) guidelines,

- Emission potential for Electricity = 158.06 kg CO_2e / MMBtu = 0.539 kg CO_2e / kwh
- Emission potential for Steam = 73.78 kg CO_2e / MMBtu = 0.252 kg CO_2e / kwh
- Emission potential for Electricity from Renewable Sources = 0.041 kg CO_2e / kwh

EXAMPLE:

Water flowing at the flowrate of 100,000 kg/h and at a temperature of 40 0C, would require Low Pressure Steam at a pressure of 50 kPag, temperature of 111.3 0C and flowrate of 7600 kg/h to raise temperature of water up to 80 0C. The heat duty delivered is 4813 kw. Therefore,

1) When used electricity for delivering required heat duty the emission generated is estimated at = 0.539 kg CO2e / kwh X 4813 kw = 2594 kg CO2e /h.

2) When used steam for the delivering required heat duty the emission generated is estimated at = 0.252 kg CO2e / kwh X 4813 kw = 1213 kg CO2e /h.

3) When used Renewable energy for delivering required duty the emission generated is estimated at = 0.041 kg CO2 e / kwh X 4813 kw = 197 kg CO2e /h.

- Annual emission reduction resulted due to use of 60 % of renewable energy is estimated at=501,072 kg CO2e.

CONCLUSION:

It is worth mentioning again that the electrification does not seems supported by the emission estimation numbers compared to the steam (current operations), however, electrification is the preferred route which could lead to the partial or complete elimination of the emission with the deployment of the renewable resources.

The distinct benefits in the form the water conservation are realized with electrifications

The proposed technology/solution would definitely help with the Oilsands corporate's net-zero commitments. The way existing operation is carried out have slim chances that the oilsands industry would be able to cut emission associated with the froth deaeration operations; unless the electrified boilers used for steam production and the electricity is sourced from the renewable energy sectors.

The proposed solution involves electrifications of the deaeration process which will allow the industry to employ and gradually increase the share of the renewable energy to achieve net-zero targets. Although grid based electricity involves higher emission potential than the steam produced from the boiler, the proposed technology allows the industry to deploy the energy sourced from the renewable sources immediately and subsidizing the emission footprint from day one and not to enough emphasize that it significantly benefits from water conservation perspective.