HPU TOPICS OF INTEREST:

1. **OIL & GAS INDUSTRY**
   a) Cleaning of Produced Water in the Oil and Gas Industry
   b) Oil Sand
      - SAG-D Enhancement
      - Bitumen Extraction Process
      - Pipelines, tanks etc.

2. **RENEWABLES**
   a) Enhancement for Biomass

1. OIL & GAS INDUSTRY

a) Cleaning of Produced Water in the Oil and Gas Industry

Produced Water, is water produced during both upstream and downstream Oil & Gas operation.
Can HPU support to generate clean water from the most difficult produced water sources such as FRAC water, SAG-D water and polymer flooding?

As we understand, today it is done with membrane separation systems that exceed the most demanding HSE measures. The membranes are placed in a container which makes the membrane system easily transportable and fast to set up. Usually it comprises a feed pump, recirculation loops, a cleaning unit and a fully integrated control panel.

The membrane technology allows producing water with a TSS content < 1 mg/L and an oil content < 1 ppm. The ceramic membranes create a solid barrier that dispersed oil, solids and even bacteria will not be able to penetrate. This means that very pure water can be produced, with low amounts of oil and solids. The system can work without the addition of chemicals, and is able to operate at high temperatures. For example, it is possible to utilize steam for disinfecting and cleaning the membranes.

Do you envision an Ultrasound application to either replace the membrane as a separation technology or do you believe it could be used complementary?

I am electronics engineer and not an expert in water purification technologies. I think that ultrasonic water processing is not enough to realize sufficient or total water purification. Traditional, mechanical, thermal, chemical and ultrasonic processing could be combined before final filtering in order to produce clean, potable water.

High intensity ultrasonic processing will accelerate and optimize chemical reactions, minimize use of chemicals, minimize need for external heating, optimize filtering, accelerate precipitation of particles, eliminate scaling of minerals, eliminate biofilm…

My contribution here could be in supplying proper ultrasonic equipment, meaning in design and production of necessary ultrasonic hardware, since I control design, R&D, and production of my ultrasonic transducers, sonotrodes, generators and other elements, and I can make direct and fast equipment modifications in any step (without being dependent on what is available on the markets). I focus my efforts to offer different ultrasonic equipment, such as:

A) High intensity, high amplitude Sonicators (mixers, homogenizers), like ultrasonic jet or torch sources: to make high ultrasonic surface-power-density sonicators for mixing liquids. Such systems are very good to inject high quantity of ozone in polluted water. Ozone is creating high level of oxidation, neutralizing odors and poisons, and killing bacteria… this way realizing total sterilization and an excellent chemical decontamination. Other applications of such high amplitude sonicators are related to Sonochemistry and nano particles production…

B) Sonicators for high volumetric power density of ultrasonic activity in liquids. Such ultrasonic equipment is applicable for acceleration of chemical reactions, acceleration of solid particles precipitation, for creating nano particles… If we combine traditional, mechanical, thermal and filtering processing with such ultrasonic processors, we can get faster and better results regarding water decontamination (especially if we also inject ozone in water).

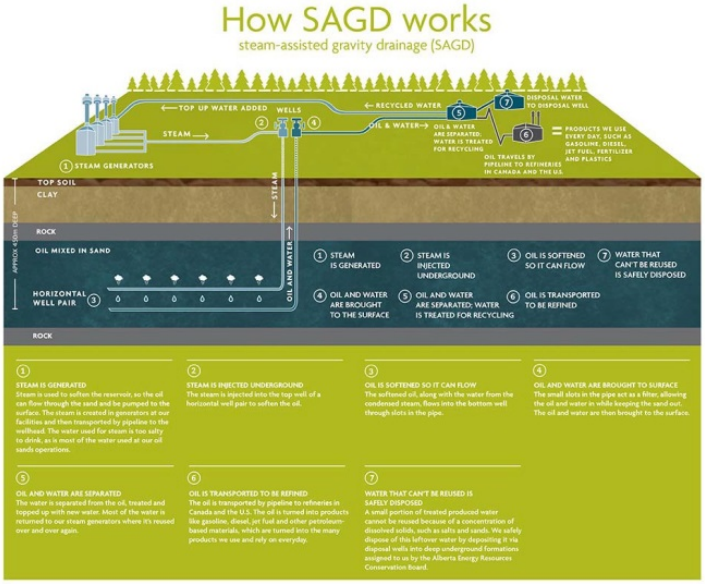
C) Ultrasonic reactors where spectrum of cavitation is very rich. Cavitation is making decontaminations, oxidation, sterilization, surface processing, nano-particles creation, sonochemistry stimulation… There are positive and negative sides of such treatment (to be discussed). Anyway, even such ultrasonic processing should be combined with other methods of traditional water purification. Here we can also inject ozone in water and optimize results.

b) Oil Sands

The oil sands are loose sand or partially consolidated sandstone containing naturally occurring mixtures of sand, clay, and water, saturated with a dense and extremely viscous form of petroleum technically referred to as bitumen, or tar owing to its similar appearance, odor and color. Bitumen is a thick, sticky form of hydrocarbon, so heavy and viscous (thick) that it would not flow unless heated or diluted with lighter hydrocarbons.

- **SAG-D Enhancement**

Because bitumen flows very slowly, if at all, toward producing wells under normal reservoir conditions, the sands must be extracted by strip mining or the oil made to flow into wells by in-situ techniques, which reduce the viscosity by injecting steam, solvents, and/or hot air into the sands. These processes can use more water and require larger amounts of energy than conventional oil extraction, despite many conventional oil fields also requiring large amounts of water and energy to achieve good rates of production.



We understand that SAG-D already includes the use of hot water (Steam) and in some cases solvents. As per our understanding, High Intensity Ultrasonic Agitation will make a fast and efficient oil extraction. The injection and producing wells are all located in a range of 450 meters below surface.

Limitations of ultrasonic processing equipment: High temperatures (more than 80°C), high density and high viscosity multi-phase liquids, sticky masses, liquid turbulences, presence of steam and gaseous phase, high flow rates and high speed of liquid streaming, high hydrostatic and dynamic pressure… are among highly disadvantageous and negative situations and environments for realizing efficient ultrasonic processing… here we could discuss… Ultrasonically we can successfully treat already liquefied mass and make it much more homogenous, dissolving most of high density components, realizing fast oil extraction, meaning that initial technological steps will stay traditional (mechanical, thermal…).

Based on your emails, you mentioned that such Ultrasonic equipment could be manufactured.

Could you use the same tool set-up as developed by you for Progress Ultrasonics Group called the "*Ultrasonic Well Stimulation System used for stimulation of oil production*"?

YES and NO. Probably design needs to be modified. Should be tested… success depends on situation and combination of factors… The optimal will be if we can use very high intensity Sonicators, but preferably in reservoirs on a surface (not underground). We will discuss…

You would have to determine if there is a way to manufacture a tool capable to work in the high pressure SAG-D wells or if you would have to go into the bottom production wells or if there is a different way to provide the ultrasonics down to 450 meters below surface. Of course the best would be if we could develop a stimulation tool working continuously. There is significant power source and continuous operations in place.

Not sure what to say (too wide problematic with number of obstacles)… in easy situations of oil wells this could work well… but in heavy duty conditions, effects will be significantly reduced… We have better and easier chances when working on a surface (not in boreholes)… I could propose other, more innovative options (but still not tested in such applications). To be discussed.

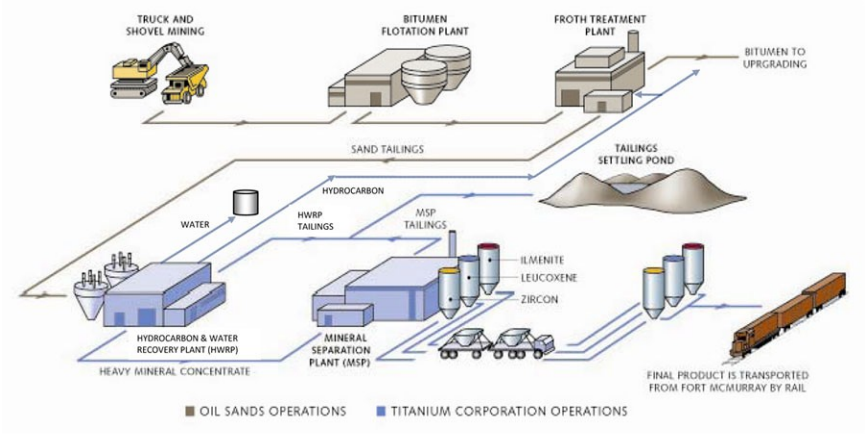
- **Bitumen Extraction Process**

Oil sands are sand and rock material which contains crude bitumen (a heavy, viscous form of crude oil). Oil sands are found primarily in the Athabasca region of northern Alberta, Canada, and in areas of Venezuela.

Large areas of land are cleared of trees and brush, then the top soil and clay are removed to expose the oil sand. This surface mining method uses large trucks and shovels to remove the sand, which can have volume of anywhere from 1-20% of actual bitumen. After processing and upgrading, the end result is sent to refineries, where it's made into gasoline, jet fuel and other petroleum products.

Processing Operation

The heavy minerals contained in the oil sands deposits are concentrated by the bitumen extraction/recovery process (en route to oil production). The majority of these minerals are contained in the oil sands froth treatment plant (FTP) tailings stream.



We are interested in delivering an enhanced treatment process in the production of bitumen. As per the above graph, in what area do you believe ultrasonics would be a great benefit?

Ultrasonic processing can significantly contribute in chemical and hot water dissolving, mixing, and homogenization of water with bitumen, waxes, paraffin and asphaltenes. For efficient ultrasonic processing it is necessary to have less than 15% content of solids in water. Total, average (mixed) density and viscosity of liquids under processing should be similar or close (comparable) to water.

- Pipelines, tanks etc.

We have not spent much time in discussing such applications but we do understand that ultrasonic is used in cleaning processes. We envision the development of a continuously placed HPU system like a bandage placed around pipelines, casings, tanks and so on to keep it from build-up of scale and so on.

Yes, possible… here we could discuss…

2.
RENEWABLES

a) Enhancement for Biomass for Bioethanol, Biodiesel and Biogas

We do understand that the integration of high power ultrasonics to the production of renewable energy such as bioethanol (starch and cellulosic), biogas and biodiesel will considerably improve the technical and the commercial efficiency.

We also understand that the use of ultrasonics as a pre-treatment of corn slurry has the potential to reduce the corn particle size almost 20-fold and to free lipid-bound starch due to acoustic cavitation. In addition, it also facilitates better mass transfer of enzymes due to intense mixing resulting from acoustic streaming. The glucose release of corn slurry treated with ultrasound can improve up to 30% compared with non-sonicated corn slurry.

There are several areas in the ethanol process where industrial high power ultrasound could be applied. For each area the tool would be designed and tailor made accordingly and we believe that

the use of ultrasonic technology provides a practical solution to significantly improve ethanol yield at a lower cost by addressing all of these possible improvements.

Thus, the integration of an ultrasonic unit prior to liquefaction and saccharification could enhance the overall sugar release from corn for subsequent fermentation to ethanol.

Yes, correct… liquid biomass ultrasonic agitation is making smaller particles, better mixtures, dissolving, degassing… and later applied biological or bacterial processing is much more efficient…

We also understand that there are additional Areas for Ultrasonics in Biofuels production such as:

- Optimizations regarding heat exchangers: ultrasonic excitation of heat exchangers in order to make internal cleaning and increase heat exchange in-line, without stopping the process.

  This is very good and practical application (heat exchangers, boilers, pipelines free of scaling)…

- Ultrasonically assisted filtering, mixing and degassing of liquids.
- Water softening to avoid creation of hard mineral layers (scaling) in boilers, pipelines tanks etc.
- Improve the transesterification kinetics significantly and can process triglycerides into biodiesel within minutes. Lower excess methanol and less catalyst are required.
- Pre-treating cellulosic material with ultrasound makes lignin removal so efficient that sugar dissolution occurs in minutes rather than the hours needed with traditional mixing systems.
- The application of ultrasonics to the processing of organic waste streams can achieve various results, such as:
  - Increase in biogas yield
  - Improved anaerobic decomposition
  - Improvement of sedimentation behavior due to degassing and flake disintegration
  - Improvement of C/N-ratio for de-nitrification
  - Improvement of surplus sludge thickening
  - Improved digestion and dewater ability
  - Reduction of the amount of flocculants
  - Lower disposal costs due to reduction of residual sludge after digestion
  - Reduction of required polymer
  - Destruction of filamentous bacteria

Are you able to provide us with some guidance in what area your expertise could help in developing a system to make biomass treatment more efficient? We do understand that there is already equipment available for such processes. However what we are looking for is a "Black Box" to be installed at our own cost at existing bio-ethanol and bio-gas facilities whereby our profit would only be based on performance.

I can supply high intensity Sonicators… everything else you could make yourself… Of course, I can give instructions… We will discuss options. Basically, I do not like to discuss too much about different technologies, since most of my experience is in design of ultrasonic equipment. I can offer several of Sonicators that are known as good for liquids processing, we can make different design modifications and adaptations.