

The process technology of the hydrothermal carbonization

Summary

Hydrothermal carbonization (HTC) is a process technology to convert different sorts of biomass in aqueous solution into different sorts of bio-coal, a process which is exothermic in nature.

All sorts of biological waste and residual materials can be used for example waste materials from the vegetable oil production, output waste from biogas plants, horse manure and horse straw as well as clarifying sludge and biological household waste.

Reaction products are different forms of bio-coal, from topsoil, over brown coal to hard coal as well as organic nutrients and humins in aqueous solution.

The process can also be used to re-use complicated waste like clarifying sludge to get back biological nutrients on the one hand and biofuel on the other hand to save energy costs in an environmentally friendly way.

Again the process can be used as a highly efficient and economical way to store carbon dioxide in the form of bio-coal, which can be used as a long-term fertilizer.

The Background

The hydrothermal carbonisation is a chemical process for the fabrication of brown coal, liquid precursors of crude oil and topsoil coal from biomass while generating energy. The progress from brown coal to hard coal, which needs thousands of millions of years in nature, can technically be implemented within some hours.

The process

In a pressure-generating apparatus biomass (e.g. waste materials from agricultural production), water and a catalyst are being heated up in the absence of air.

The apparatus is similar to a steam cooker. The on-going reaction is exothermic in nature, meaning that energy is being released. After 12-18 hours the educts are completely converted and the result is a wet sludge consisting of porous brown coal globules.

In this chemical process practically 100 percent of the raw material's original carbon is being bound as coal or topsoil. While 66 percent of the original calorific value are remaining in the coal, a third of the energy is being emitted as process heat.

This means that after heating of the biomass in water up to a reaction temperature of 160-200 degrees Celsius (the energy for triggering the reaction) a larger quantity of energy is being released from the exothermic process. There is the option of storing the thermal energy and using it for heating up the next reaction process.

What materials can be used?

Our reactor system converts waste materials from the vegetable oil production, but can also be adapted to different raw and waste materials like output waste from biogas plants, horse manure and horse straw as well as clarifying sludge. The biomass does not have to be dried and can be processed in a wet state. Practically all kinds of biological, organic or crop wastes can be utilized. Whereas in the vegetable oil production only the "fillet" of the crop is being exploited our process technology can make use of the whole crop material – thus raising the ecological and economic value.

Reaction products

The process can be adjusted so the coal is a bit refined, or it can be processed until it's like hard coal. One end of the spectrum is topsoil, the other is hard coal. When the coal mixture is being processed for just five hours, the result is topsoil. Soft lignite requires nearly as much cooking as hard coal. The nutrient-rich earth can be used to help barren landscapes bloom.

The product properties which meet great ecological and economic demands result from the combination of the advantages of a long-lasting fertilizer and the properties of a high-grade stable humus. The nutrients of the biomass waste are being accumulated in the liquid phase – the water of the reaction.

Obtaining a valuable bio-coal for thermal usage is a definitive ecological and economical alternative to the usage of conventional fossil fuels.

It is also possible to put the input matter for a short reaction time in the reactor for hygienic purposes.

Market potential

Examples:

In Germany there are about 1 million horses, and 17,5 kg used straw per horse have to be handled every day which have to be disposed.

Every year 3,5 million metric tons of clarifying sludge resulting from the waste water handling have to be processed cost-intensively and afterwards be disposed with incurring cost of 200-600 Euro per metric ton.

Originating from 4.000 biogas plants there are large amounts of fermentation leftovers which have to be processed and disposed in a cost-intensive way every year.

Demand for biofuels

In Germany about 1.2 million metric tons of wood pellets with a price of 175 Euro per metric ton (August 2008) are being produced and sold per year. The price of a metric ton of wood chips is 80 Euro per metric ton (August 2008).

Usable potentials regarding the cost reduction

Various possibilities regarding the large cost reduction can be seized by reducing the costs for waste disposal and utilizing so-called waste material as valuable biofuels (for example as chips/pellets or briquets). Thus these biofuels can be used for generating heat and electricity.

Outlook

Carbon storage application

The IPCC report claims that anthropogenic warming and sea level rise will continue for centuries due to the timescales associated with climate processes and feedback, even if greenhouse gas concentrations were to be stabilized immediately. It would therefore be highly desirable to not only slow down further CO₂ emissions, but also to invert the current development by sequestering the atmospheric CO₂ released by many years of industrialization.

The biggest carbon converter, with the highest efficiency to bind CO₂ from the atmosphere, is biomass. Interestingly, the removal of just 8.5% of freshly produced biomass from active ecosystems would compensate for all the CO₂ liberated from oil. Coal formation from biomass is one of

the natural sinks that has been active in the past on the longest scale. This form of storing Carbon is practically permanent since certain coal types are not biodegradable. In development countries it is possible to generate emission certificates for trading purposes.

Using the generated carbon topsoil and the liquid crop nutrients it is possible to restore eroded soils. Flourishing crops result in further natural carbon sinks.

New synthesis paths for chemical carbon

The resulting carbon has a specific porous structure – depending on the process parameters (comparable to a „cooking recipe“). Further applied research and development will enable the synthesis of valuable active carbon. Furthermore carbonbased raw materials and chemical additives for the chemical industry are technically feasible.