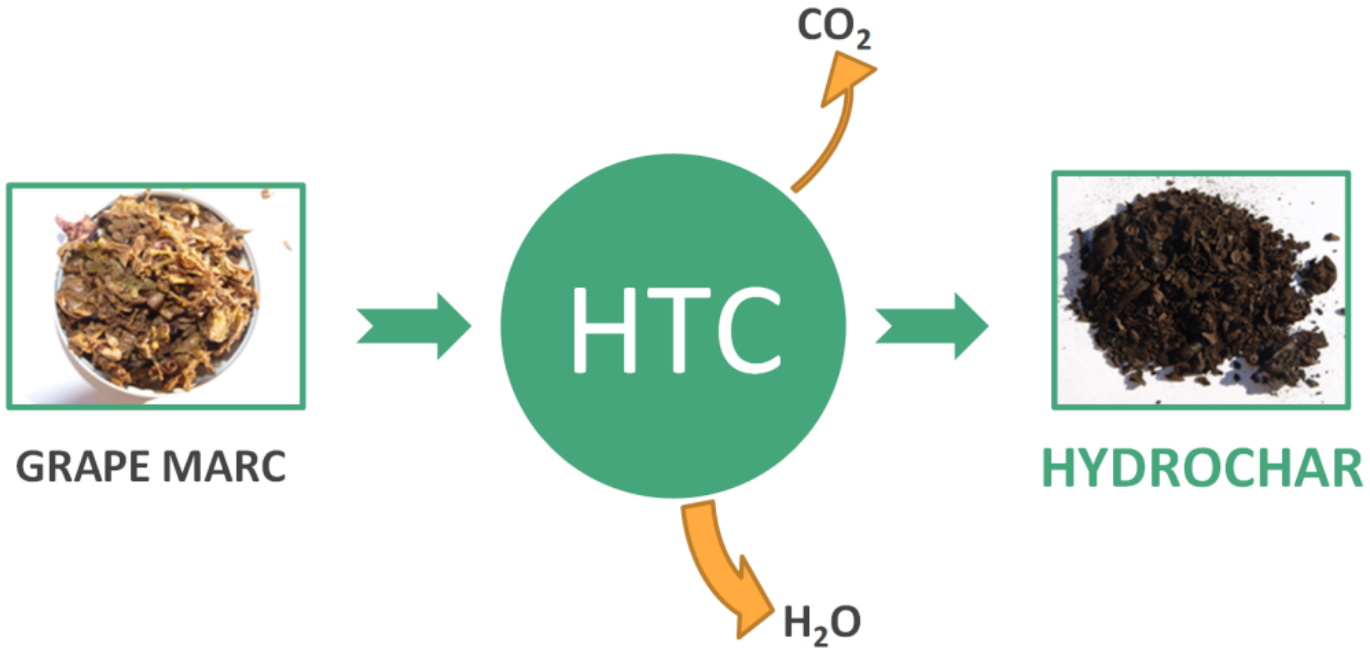
Innovative solid biofuel production from grape marc through hydrothermal carbonization

Geological ages and appropriate conditions are necessary to transform biomass into coal: with the hydrothermal carbonization, the same result is obtained in a few hours!

Hydrothermal carbonization (HTC) is a thermochemical process through which it is possible to transform vegetable residues into an energy dense material, called hydrochar. If compared to other thermochemical processes, such as pyrolysis or gasification, HTC is simpler to be applied at industrial scale, because it involves temperatures (180-250 °C) and pressures (10-50 atm) quite easy to be handled. Moreover, HTC is particularly suitable to treat vegetable residues having a high moisture content (60% or greater) because, during the process, the hot pressurized liquid water acts both as a medium and as a reactant. During HTC, the biomass undergoes both dehydration (loss of H_20) and decarboxylation (loss of CO_2): consequently, the substrate increases its carbon content, loses oxygen atoms and thus its calorific value is enhanced. The interest risen on HTC is mainly because it can be applied directly to the raw biomass, in contrast to other alternative processes, such as pyrolysis or direct combustion, which need the substrate to be previously dried. This pre-treatment could make the energy production not convenient, being the drying process energy intensive.



In the northeast of Italy, there are lots of wine industries and alcohol distilling companies, which produce as by-product grape marc. Actually, everywhere wine is made, grape marc is also produced. Grape marc is an organic residue composed by grape seeds and grapes skins (and

possibly stalks), having about 70-80% of humidity. In our research, we studied the possibility to carbonize the grape marc, to produce hydrochar for energy purposes. At the Department of Civil, Environmental and Mechanical Engineering of the University of Trento (IT), we set up an experimental apparatus, through which carbonization tests on grape marc were performed. In particular, the substrate was carbonized at three temperatures, namely 180, 220 and 250 °C, and three residence times (1, 3 and 8 h). The results show that the hydrochar obtained has a calorific value which ranges between 24.1 to 29.8 MJ/kg (with an average value of 26.5 MJ/kg), similar to the heating values of low rank woody coals. With respect to the calorific value of the raw feedstock, these data confirm that the HTC process can increase from 24% up to 54% the energy content of the original material. In terms of mass yield, evaluated as the ratio between the mass of hydrochar produced and the mass of raw feedstock treated, the HTC process averagely preserve 67% of the total mass, depending on the operating conditions. In fact, the higher the temperature and the longer the residence time, the lower the hydrochar yield. Considering the gas produced, it is mainly composed of carbon dioxide, with some traces of carbon monoxide, mainly at higher temperatures. However, the gas yield evaluated as the total amount of gas produced by the reaction, has been calculated not to exceed the 9% of the mass of the raw feedstock, with an average value of 6%. The small amount of gas produced and its composition represent an interesting advantage of the HTC process with respect to the other processes, because the lower the gas produced, the higher the hydrochar yield and the lower the environmental constraints to overcome when implementing the process at industrial scale.

As a whole, the results we obtained support the possibility to exploit the HTC process to energetically valorise grape marc.

Publication

Agro-industrial waste to solid biofuel through hydrothermal carbonization.
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