Evaluation of the efficiency of a scrubber Venturi in the collection of particulate matter smaller than 2.5µm emitted by biomass burning

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The search for renewable sources of energy becomes more relevant as the global energetic demand increases, associated with the population growth. The emerging trend in the use of bioenergy in many countries intensifies the international debate on environmental impacts, deforestation, biodiversity reduction and health problems, particularly due to water quality and air pollutant emissions. The use of sugarcane bagasse as biofuel in industry and distilleries has intensified. Consequently, pollutant emissions generated from biomass burn affect local and the global population. Sugarcane is the most widely used biomass in Brazil due to the large agricultural availability of this product. In distilleries, the industrial burn of sugarcane bagasse releases hot steam which drives turbines to generate energy. The combustion vapor contains an enormous amount of inorganic ions (NO_3^-, SO_4^{2-}, NH_4^+, K^+), particulate matter (MP), volatile organic compounds (benzene, levoglucosan), among others. In order to control the emissions of these pollutants into the atmosphere, it is necessary to install industrial collection equipment capable of treating the effluents at the boiler outlet. The emission control can be performed using cyclones, sleeve filters, precipitators and scrubbers. Considering the relevance in the use of biomass as industry fuel, and the emerging need of a technique able to efficiently remove pollutants originated from the biomass burn, this study aimed to evaluate the emissions caused by sugarcane biomass burning and the efficiency of a scrubber Venturi as control equipment. Sugarcane bagasse (biomass) was used for the tests. All the firing material was previously grounded and naturally dried (outdoors) to remove water, reaching a final moisture of around 7%. The scrubber Venturi, located between the burner and the cyclone, has a rectangular geometry of 117 mm in throat length, 2.4 cm in width and 3.5 cm in height. Water was used as washing liquid. The liquid-gas flow ratios were 0.6, 0.7, 0.8 and 1.1. Sampling was performed by positioning portable isokinetic samplers before and after the Venturi, in addition to sampling the smoke plume by means of an 8 stage Andersen cascade impactor. Samples were conducted for 20 minutes after the fuel burn process reached the established regime. The burning of biomass emits high concentration of particles smaller than 2.5 µm. The results showed that the scrubber Venturi was very efficient in the collection of MP>2.5µm and MP1.0-2.5µm, with less collection efficiency for MP <1.0 µm. For the liquid-gas flow ratios of 0.6, 0.7, 0.8 and 1.1 the efficiencies were 92, 89 and 75% average, for stages 1, 2 and 3, respectively. The best efficiency result obtained so far was 93% for particles smaller than 0.1 µm obtained with the liquid-gas flows ratio 1.1. The scrubber Venturi was very efficient in the MP collection larger than 2.5 µm and between 1.0 and 2.5 µm. The temperatures in the combustion chamber were higher than 900 °C and in the exhaust gases ranged from 150 to 275 °C. For the results of monitoring in the plume of smoke, the highest rates obtained were for the smaller diameter range of 0 to 0.4 µm, raising to the highest values of 500 to 12,000 mg/h. The fraction corresponding to the fine particles ($MP_{0-0.4µm}$) was emitted in higher concentration, ranging from 7786.7 to 19466.7 µg/m^3. The main ionic species found in $MP_{0-0.4µm}$ were potassium, chloride, nitrite and sulphate. Potassium and sulphate presented higher concentrations. Calcium and chloride were also found in the other diameters. The presence of potassium and chloride emitted by the burning of agricultural biomasses is related to the use of pesticides and fertilizers that are applied in the field. The species evaluated in the highest concentration in the different filters of the isokinetic samplers were potassium, magnesium calcium ammonium and nitrate for MP>2.5 µm; potassium, chloride and nitrate for MP1.0-2.5µm and sulphate, chloride, phosphate, and potassium for MP <1.0 µm. Therefore, scrubbers Venturi are a promising tool in the removal of pollutants presented high collection efficiency and can be used easily various industrial processes.