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Recycling process viability from zirconium alloys scraps of lathe melted in the vacuum arc remelting (VAR) furnace

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Pressurized water reactors (PWR) commonly use U235 enriched uranium dioxide pellets as a nuclear fuel, these are assembled and cladded in zirconium alloy (M5, Zirlo, Zircaloy) tubes and end caps. During the machining of these components, large amounts of turning lathe chips are generated which are contaminated with cutting fluid. Its storage presents safety and environmental risks due to its pyrophoric and reactive nature. Recycling industry has shown interest in its recycling due to its strategic importance of these scraps. This paper presents the steps on the recycling processes and the results for the search of an efficient way on the cleaning, quality control, manufacturing, and melting of electrodes for Vacuum Arc Remelting (VAR) furnace. The process starts with cutting oil washout and this step consists of a water dissolution followed by a degreasing process, the water rinse by continuous flow of water and finally drying in hot air. Process evaluation was first made by means the X-ray fluorescence tests in order to define the quality of the scraps that after washing were pressed in 20 mm diameter briquettes, melted and subjected to such analysis. The next step consists in the pressing with a die square section with 40 mm2 and 500 mm long, producing an electrode with 20% of the Zircaloy bulk density. The electrode was melted in a laboratory scale VAR furnace located at the CCTM – IPEN producing a 0.8 kg ingot. The microstructural and macro structural characterization is being done by analyzes performed in the optical microscope and scanning electron microscope (from portuguese Microscópio Eletronico de Varredura - MEV). Gas analyzes were carried out with the intention of evaluating possible gases resulting from the melting and evaluating their influence. X-ray diffraction analyzes were also performed to identify the phases present in the material after the melting process The authors conclude that the samples obtained from the fuel element industry can be melting in a VAR furnace reducing 40 times the storage volume, however, it is necessary to remelt the ingots by correcting their composition intended for reuse.