Production of spherical aerogels using compressed CO_2 - from laboratory to industrial scale

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1. Introduction

The demand for high-performance and cost-effective materials for thermal insulation is increasing rapidly. In addition to established systems such as petroleum-based foams, sandwich elements or mineral or glass wool, aerogels are also increasingly coming into focus. Aerogels are nanoporous solids characterised by low density (0.003-0.3 kg/m^3), high porosity (up to 99 %) and a large surface area (600-1000 m^2/g). 98 % of the aerogels available on the market are silicate aerogels, which with a thermal conductivity of approx. 0.02 W/m*K clearly undercut established insulation materials. In addition to fibre-reinforced aerogel mats, particulate aerogels are used in industrial applications. These offer the advantage that they can be used variably in a wide range of applications, e.g. as fill or aggregates, so that demand is continuously increasing. In particular, the application in the field of building insulation in the form of thermal insulation plasters is considered a promising application. However, significant market penetration currently still is inhibited by the high production costs.

2. Results

In the last 7 years Fraunhofer UMSICHT has developed a new manufacturing process for spherical aerogels in cooperation with its industrial partner PROCERAM. The production process is based on the direct dripping of a precursor in compressed CO_2 and the execution of all further process steps like gelation, ageing, solvent exchange, hydrophobisation and drying under the presence of supercritical CO_2. Dry aerogels are removed immediately after the end of the process. Relevant cost reduction was achieved by reducing the use of acids as well as solvents and hydrophobing agents. In parallel it was found that the overall process time can be shortened considerably without affecting the quality of the aerogels. The process has been demonstrated to produce spherical aerogels with a diameter of up to 5 mm, at a total process time of 2.5 hours. The particles have successfully be applied and tested in insulation plasters. For the first time, the presentation gives an insight into the development and scale-up strategies, starting in the laboratory scale of 63 mL and 2 L to the pilot plant scale of 60 L up to the fully engineered, continuously operated industrial scale.