Design of a Controlled Dosing Scheme for Liquids Using a Venturi

M. Dagaonkar[1], V. Kumaran[1], R. Venkataraghavan[1], D. C. Franklin[1]

[1]Unilever R&D, Bangalore, Karnataka, India

Abstract

Dosing a predetermined quantity of one liquid into another, in a controlled fashion, is a process often encountered in a variety of operations at both industrial and laboratory scales. This process becomes a challenging one if it has to be carried out in a continuous mode, without using any dosing pump and if the dosage levels are very small. A possible simple and elegant solution to the problem is to use a venturi. A venturi works on the principle that a fluid flowing through a pipe of decreasing diameter experiences a pressure drop, which leads to the formation of a low pressure inside the venturi at its lowest diameter. Connecting a reservoir of another fluid by means of a dosing tube inserted at that low pressure area results in suction of that fluid into the flowing stream (Figure 1). In the present work, we have modeled a venturi based dosing system using COMSOL Multiphysics. The extent of variation in dosage of the injected fluid from the reservoir with varying venturi dimensions, hydrodynamic conditions and rheology of the dosed fluid has been predicted. Velocity and pressure distribution in the venturi have also been estimated. Decrease in the cone angle (by decreasing the venturi inlet diameter or increasing the throat diameter) decreased the pressure drop and dosage (Figures 2 and 3). Increase in the diameter of the dosing tube resulted in a significant increase in the dosage of the fluid (Figure 4). Increase in the viscosity of dosed fluid significantly reduced the dosage. The predictions were further validated with experimental observations and empirical calculations. Good agreement has been observed between measured and theoretical values computed with COMSOL Multiphysics.

Reference

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Figures used in the abstract

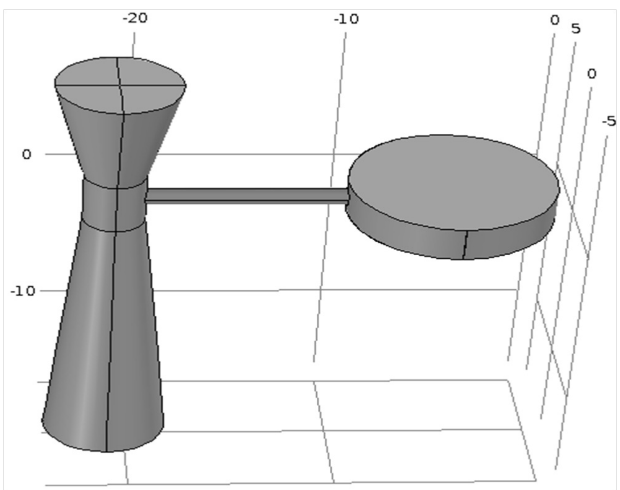

Figure 1: A typical design of venturi based dosing system.

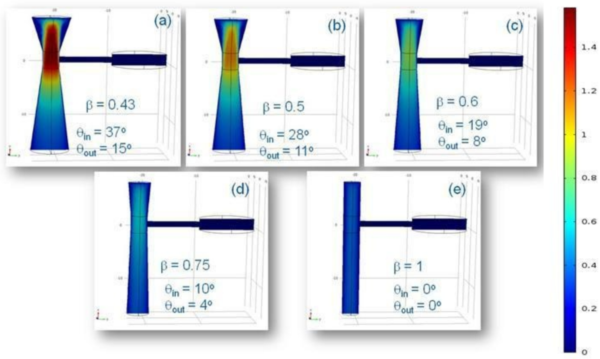

Figure 2: Effect of cone angle on velocity profiles within a venturi. Cone angle has been decreased by decreasing the inlet diameter. (is the cone angle,   is the ratio of throat to inlet diameter of venturi). Inlet velocity in Venturi = 0.2 m/s.

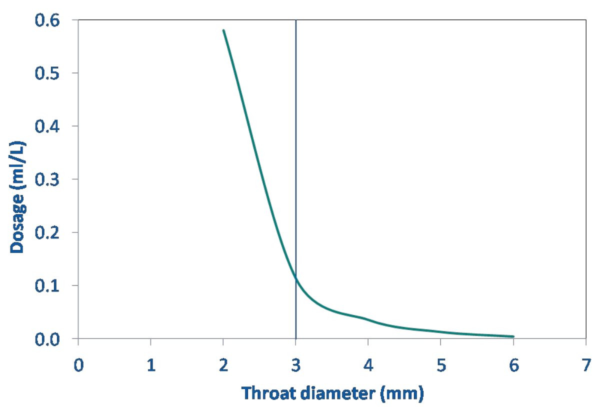

Figure 3: Effect of throat diameter on Dosage of fluid. Cone angle has been decreased by increasing the throat diameter. Inlet velocity in Venturi = 0.2 m/s.

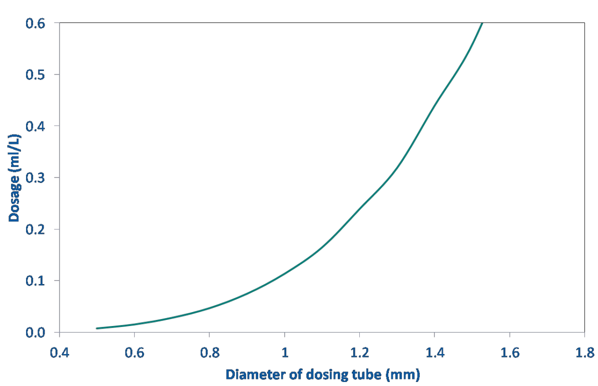

Figure 4: Effect of diameter of dosing tube on dosing of liquid.