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A heuristic method to minimise the chattering problem in dynamic mathematical two-phase flow models

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ABSTRACT

This paper introduces the chattering problem in dynamic mathematical two-phase flow models. The real system object of study is also introduced, the DISS test facility, a parabolic-trough solar power plant using as heat transfer fluid the steam–water mixture. A dynamic model for studying its behaviour was previously developed using Modelica as the modelling language, in this model the chattering problem arises and therefore not allowing to take full advantage of dynamic simulations. The chattering problem increases the computational time needed for simulation and sometimes dynamic simulations do not finish at all. A heuristic method, which minimises the effects of the chattering problem, is discussed and results which reduce the computational time for dynamic simulations are given.

1. Introduction

Chattering, in it general physical sense, is defined as an infinite number of events occurring in a finite time period, one of the most remarkable examples is impacting systems. In impacting systems, an interesting property is the possibility of chattering, an infinite number of impacts occurring in a finite time period, for instance a ball bouncing to rest on a horizontal surface [1].

In the case under study, chattering involves high-frequency oscillation in the numeric integration of differential equation systems which describe dynamic models. Simulations, where the chattering problem appears, take longer to simulate and in some cases never finish. Chattering, although it has rarely been studied, is a well-known problem [2], studies about it by Tummescheit [3] and slice-motion in automatic control systems [4–6] are worth mentioning.

The aim of this research is a dynamic object-oriented model which was previously developed to study the DISS (DIrect Solar Steam) test facility behaviour [7], a parabolic-trough solar power plant belonging to PSA-CIEMAT (Plataforma Solar de Almería—Centro de Investigaciones Energéticas Medioambientales y Tecnológicas, a Spanish government research centre). The heat transfer fluid in the DISS test facility is steam and water in a two-phase flow. This technology is known as DSG (Direct Steam Generation) as a separate steam generator is unnecessary to produce steam. See Fig. 2 [8] for an illustration of the parabolic-trough principle. In this model is where the chattering problem arises, not allowing us to take full advantage of dynamic simulations.

In this paper the chattering problem in two-phase flow models has been studied deeply in order to understand this practical problem. A heuristic approach has been developed to minimise the chattering effects in simulation and hence to

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