Int J Mater Form
DOI 10.1007/s12289-008-0246-2

Flow numerical computation through Bezier shape deformation for LCM process simulation methods

N.Montés [1], F.Sánchez [1*], L.Hilario[1], A.Falcó[1]

[1]*Universidad CEU Cardenal Herrera. C/ San Bartolomé 55, 46115, Alfara del Patriarca, Valencia (Spain)*
URL: www.uch.ceu.es. e-mail: nimonsan@uch.ceu.es;sanchezf@uch.ceu.es

ABSTRACT: The flow front advance computation is commonly used in Liquid Composite Molding simulation for design optimization algorithms, quality process performance, etc. It can be used also to take corrective decisions in on-line control systems for the flow redirection during filling. In these cases, the flow front can be composed by a large number of nodes. In particular, it can be computed by thousands of nodes using a CCD as Finite Element sensor with high resolution [1]. Therefore, a methodology to reduce it in a few significant points is required to improve the computational costs of whatever algorithm that uses the flow front behavior information. In other previous research results, a new mathematical formulation of the flow front using CAGD techniques was used [1], [2]. Therefore, the flow front is formulae in a Bezier curve permitting to represent whatever flow front shape in a few representative points. In particular the common flow front shapes can be represented in just 10 points. The flow front nodes were approximated in a Bezier curve using a least square method to estimate the control points of the Bezier curve and a projection of this into itself. In CAGD fields, there are another interesting techniques that can be used for this propose. In particular, there is an interesting topic known as "Bezier shape deformation" [3]. This topic treats the deformation of a predefined Bezier curve through vectors. Hence, whatever point of the Bezier curve can be moved using the modulus and the direction of this vector. Therefore, the velocity vector field obtained solving the flow kinematics with Finite Element Method (FEM) or Natural Element Method (NEM) can be used to deform a predefined Bezier curve. This flow front parameterization permits a continuous numerical formulation of the flow front avoiding the approximation techniques used in [1], [2]. This computation was also extended to study particle tracking during filling.

Key words: FEM, NEM, RTM, LCM, flow front, Bezier curves, numerical simulation.

1 INTRODUCTION

The flow front tracking is a common tool to compute the control actions in advanced composite manufacturing during filling. When numerical simulation tools are used, such the Finite Element Method or Natural Element Method, the flow front can be composed of a large number of nodes depending on the discretization. Therefore, a methodology to reduce the nodes of the flow front to a few significant points or even to a continuous function is valuable. For this purpose, a mathematical flow front formulation to parametric curves is proposed not only to track the flow front advancement during simulation, moreover it can be applied over artificial vision online control systems used in infusion processes, where the flow front is defined by a number of pixels of the CCD camera treated as nodes [1], [2]. In both cases, continuous functions that locate the nodes of the flow front are approximated to Bezier curves. These kind of parametric curves permit to represent numerous curve shapes with a few control points and are commonly used in CAD/CAM applications.

In this work, a novel technique is applied in order to obtain the numerical computation of the flow front advance through its Bezier curve shape deformation.

In order to analyze the proposed strategy, we have studied the tracking of several fluid particles injected in a porous media simulating the filling of a RTM Mould. The flow front evolution is updated by the shape deformation imposed by the velocity field computed with a Finite Element control volume technique.