Suction system from the self-induced mold cavity (Venturi)

F. Tonolli

Our suction system's goal is to be a valid and more simple alternative to the application of traditional vacuum system. We generate a depression in the mold cavity using the movement of air developed by the metal entering in the mold. We have designed a particular auxiliary channel directly connected to the inlet metal in the mold. The metal inlet in the mold pushes the air in this channel in a Venturi striction to increase the air speed to ultrasonic values. This develops a pressure reduction in the expander and in the connected mold cavity. In this way we experience a suck effect from mold cavity. The Venturi valve can be applied to both hot and cold chamber.

KEYWORDS: SUCTION, VACUUM, VENTURI, POROSITY;

INTRODUCTION

System layout

The particularity of our system (Fig. 1) consists essentially in an auxiliary channel (A) for the generation of compressed air. This channel is directly connected to the inlet point of the mold and to the section reduction (C) to generate the Venturi effect. With this section reduction we observe an acceleration of air speed to ultrasonic values, and then a pression reduction in the expander. This expander is directly connected to the mold cavity by a suction channel (B) and for this we can suck air from the cavity.

Obviously, we need to let out the air from the mold. For this we need a chill vent (C) in the end position. The auxiliary channel is nothing else that a container of air that we push to the Venturi restriction to generate a complete Venturi effect.

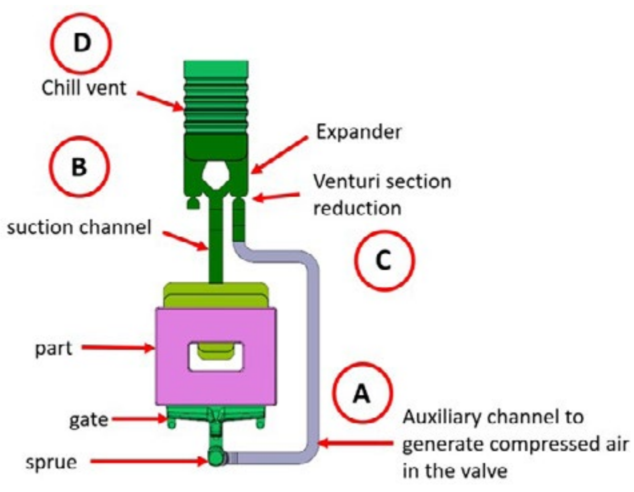

Fig.1 - System layout.

F. Tonolli
TF, Villa Carcina, Italy

The principle upon the valve is based is the principle of energy conservation for a fluid.

$$p + \frac{1}{2}\rho v^2 = cost$$

As the speed increase the pressure decrease (the geodetic term is negligible).
Key aspect of design: the metal must reach the expander after we have filled the cavity. When the metal reach the expander the suction phenomenon ends

FEATURES

Follow some characteristic of this system:

1. Reduction of pressure in the cavity
2. Reduction of porosity in the die part
3. Easier to fill 'shaded' areas with respect to the molten metal flow
4. Gradual generation of vacuum in the cavity
5. No need of external equipment (suction pumps)
6. Fully calibrated on the application
7. If properly designed, it is foolproof

From the comparison with passive or active systems (vacuum) the Venturi valve places in the between.

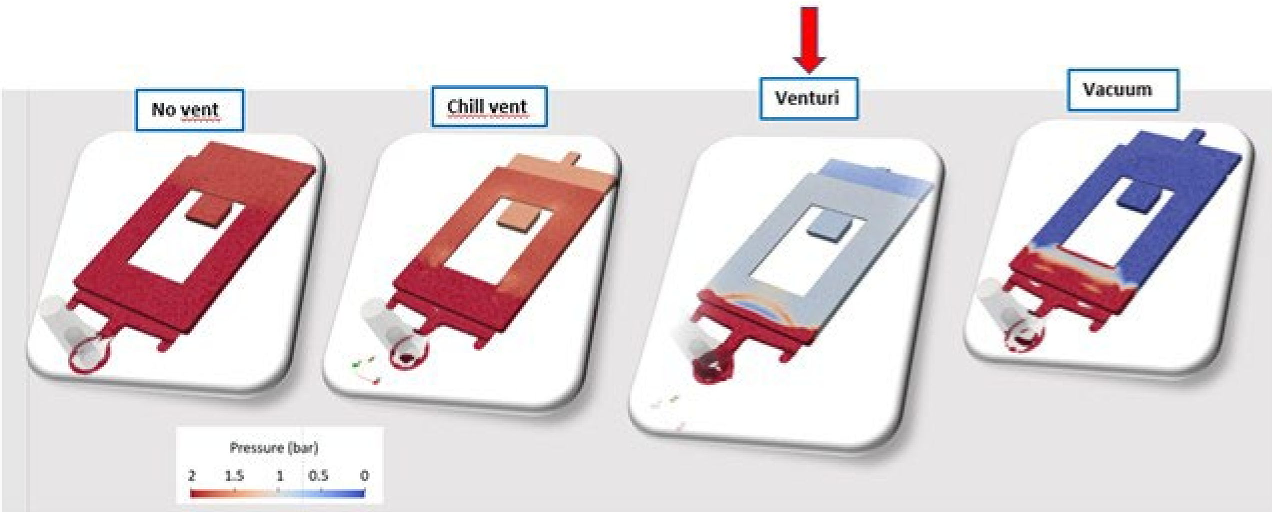

Fig.2 - Comparison with other technology (air pressure in cavity).

The venturi system is worse of a vacuum system but better of any other passive system (Fig 2).

VACUUM GENERATION

Since the vacuum is generated by the metal entering in the mold, the aspiration effect increases as the mold is filled. Small aspiration at the beginning, big at the end.
In the follow pictures you can see as at the beginning we must compress the air inside the auxiliary channel (Fig. 3). For this we experiment a delay with little depression in the starting stage. After this the system starts to work and the air pression inside the mold cavity (in comparison to passive system) decreases (Fig 4 and 5).

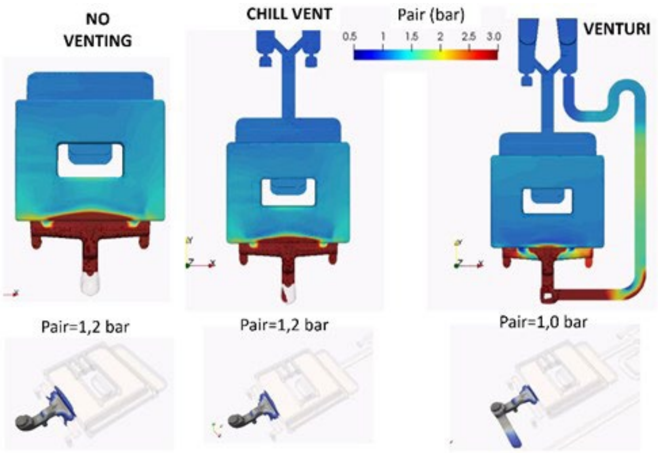

Fig.3 - Starting stage of filling (air pressure in cavity).

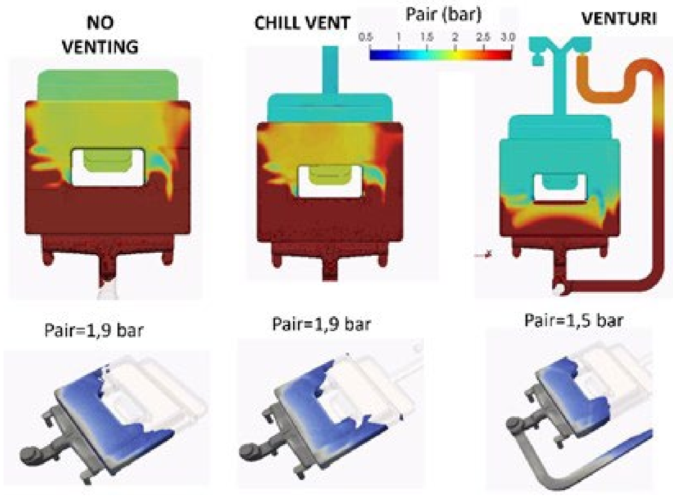

Fig.4 - Middle stage of filling (air pressure in cavity).

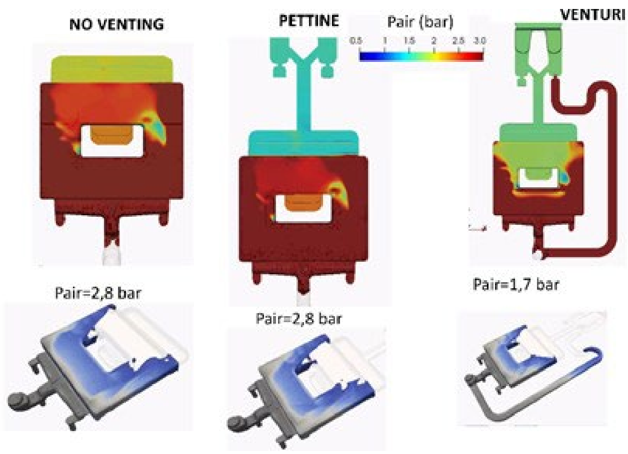

Fig.5 - Final stage of filling (air pressure in cavity).

In table 1 we have a summary of the delta air pressure in mold cavity for different filling stage.

Tab.1 - Venturi pressure reduction VS filling phase.

filling phase	Delta pressure
Start filling	-200 mbar
Half filling	-400 mbar
End filling	-1100 mbar

Valve design – APPLICATION

The box design of valve is geometric compatible to the standard vacuum valve on the market. To overcome the variability represented from the auxiliary channel that can come from left or from right we have designed a double valve (Fig. 6-7). This valve can also be used to maximize the aspiration using a double configuration (Fig. 8). Different measures are available for different cavity volumes.

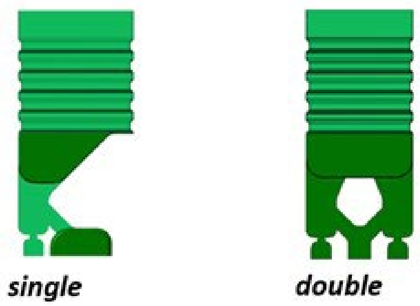

Fig.6 - Single and double valve layout.

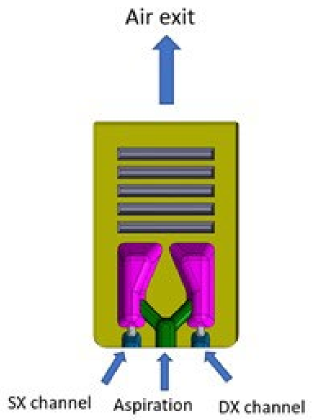

Fig-7 - VDouble valve description.

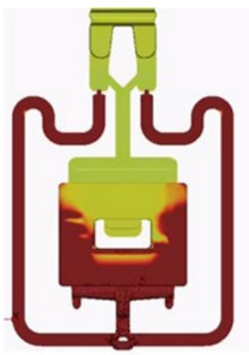

Fig.8 - Double Venturi application layout.

CASE STUDY

To test the Venturi system we have made many virtual test with numerical simulations in comparison with practical sampling either in cold and hot chamber. Interesting results are obtained for finned parts like a heatsinks where the filling is first in the thickness and after in the fins. These results are very close to the use of vacuum system (Fig. 9).

Another test was made with Zamak in which we can clearly see the different flow in the part using or not using the Venturi valve (Fig. 10)

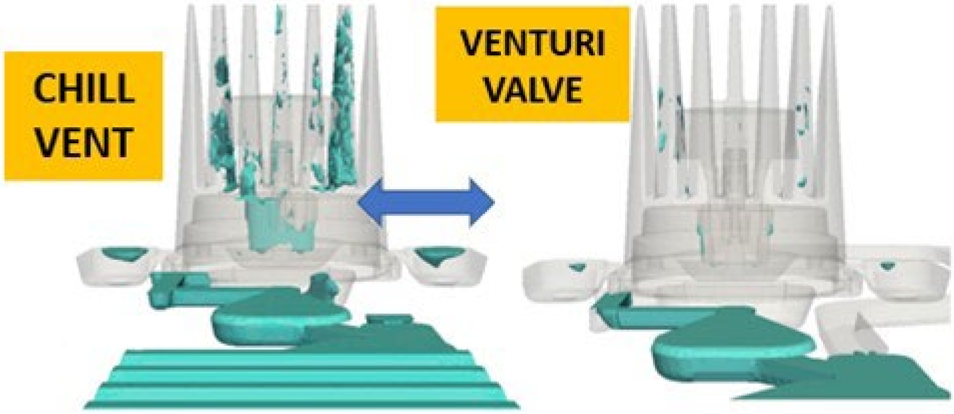

Fig.9 - Entrapped air without and with the use of Venturi valve.

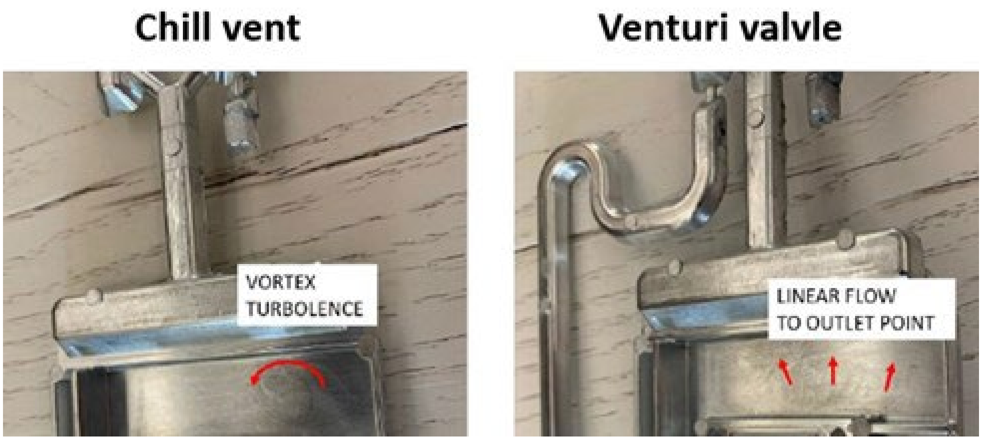

Fig.10 - Flow in real casting (ZAMAK).

REFERENCES

[1] Tonolli Francesco, inventor 'Stampo di formatura' Application Number PCT/IB2021/062327