# Effect of the Pressure Formation at the Tip of the Melt Delivery Tube in Close-coupled Nozzles in Gas Atomization Process

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**Abstract**

*Close-coupled atomizers are of great interest and controlling their performance parameters is critical for metal powder producing and spray forming industries. In this study, designed close-coupled nozzle systems were used to investigate the effect of the nozzle types and protrusion length of the melt delivery tube on the pressure formation at the melt delivery tube tip. The observed metal flow rate was not behaving as what was earlier assumed, namely that, deeper aspiration enhanced metal flow rate. Higher aspiration pressure at the tip of the melt delivery tube increases the stability of atomization process.*

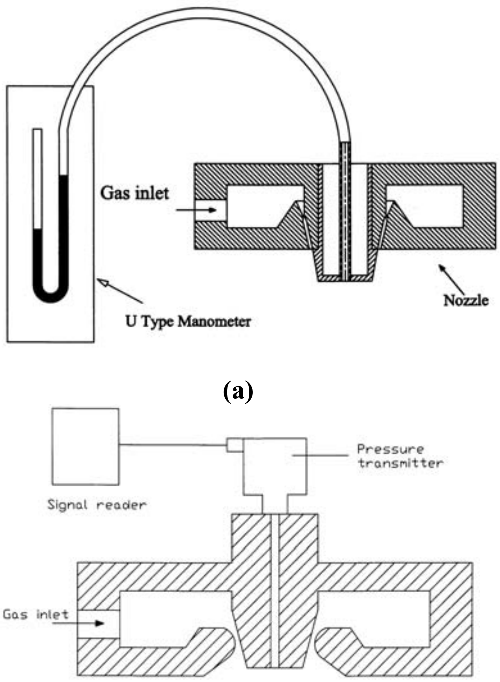
**Keywords : Gas atomization, Close-coupled, nozzle**

## 1. Introduction

Gas atomization of alloy melt is one of the curicial stages of spray forming process. For example, the gas pressure at the tip of the melt delivery tube may be markedly different under various processing conditions, i.e. pressurization or aspiration is both likely to be present in spray forming. Aspiration is favorable for drawing out the metal melt through the delivery tube, while pressurization blocks the flowing down of the melt. Therefore, investigation on the formation mechanism of gas pressure at the tip of the delivery tube is very important for controlling the spray forming process [1-3]. In this study, the gas pressure at the tip of delivery tube of two typical atomizers was measured and the formation of mechanism of pressurization and the aspiration was compared and discussed.

## 2. Experimental and Results

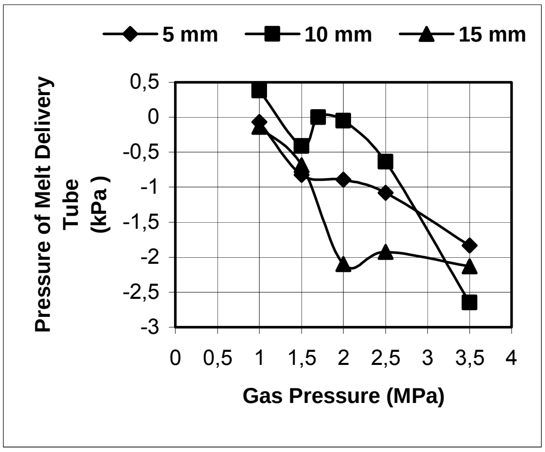
The pressure meausurement at the tip of the melt delivery tube during the atomization process is not possible. For that reason, prior to atomizing the melt, the gas-only aspiration profile of the atomizer nozzle was measured. For the discrete jet type nozzle U-type manometer configuration is used for the measuremet (Fig.1a). A pressure transmitter and signal converter was used for the concentrically slotted type nozzle (Fig.1b). A detailed description of the nozzles was given in previous papers [4,5]. Pressure difference at the tip of the melt delivery tube as a function of atomization gas pressure is given in Figure 2a.



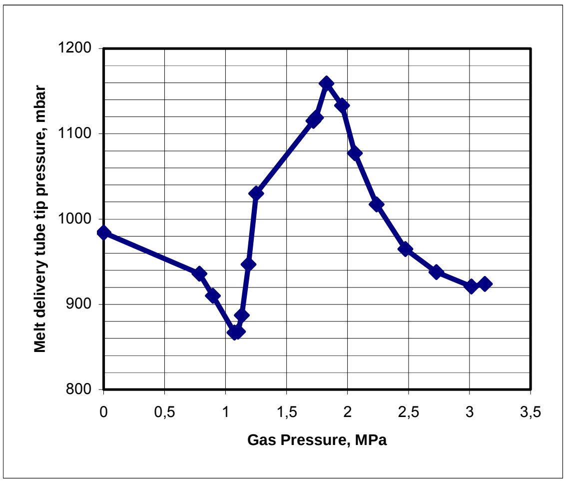

(b)

**Fig. 1. Set-up for measuring the pressure at the tip of the melt delivery tube for the (a) discrete jet type nozzle and (b) concentrically slotted type nozzle [4,5].**

It can be seen in Fig.2a that the pressure at the tip of the melt delivery tube changes with atomizing gas pressure. The data obtained from the tip pressure measurement shows that the higher is the atomization gas pressure, the higher is the negative pressure at the tip. It can be seen in Fig.2b that the tip pressure of the slotted type nozzle is greatly changing with the atomizing gas pressure. It has a positive pressure peak value of 175 mbar at 1.8 MPa atomizing gas pressure. After that pressure the tip pressure is decreasing from positive peak value down to the aspiration value of 116 mbar at the gas pressure of about 3.0 MPa. It is clear from this graphic that one can flow down the melt without applying melt overpressure when the atomizing gas pressure is below 1.2 MPa and over 2.3 MPa. There will be blocking of the melt flow between 1.2 MPa and 2.3 Mpa pressures.




**(a)**




**(b)**

**Fig. 2. The effect of gas pressure on the pressure formation at the tip of the melt delivery tube for different protrusion lengths for the discrete jet nozzle (a), tip pressure formation at the slotted type nozzle for the constant protrusion length of 10 mm (b).**

The formation of the atomization mechanism is shown in Fig. 3. Where, lateral spreading occurs at the tip of the melt delivery tube and a conic shape is formed by the influence of nitrogen jets. The gas jets always expand at the nozzle exit. The gas jet will be accelerated by expansion to a supersonic speed. This ensures that a strong radial pressure gradient along the melt tip base. In the recirculation zone downstream of the melt tip, the pressure is usually higher at the centerline. This will force the metal outwards into the part of the gas stream where it is most energetic.


**(a)** **(b)**

**Fig. 3. Pictures obtained during the atomization process by; (a) discrete jet type nozzle, (b) concentrically slotted type nozzle.**

## 3. Summary

A reasonably designed atomizer should ensure that the negative pressure is always present at the tip of the melt delivery tube for the atomization pressure. Results from this study indicated that deeper aspiration does not increase the melt flow rate during atomisation. Higher aspiration pressure at the tip of the melt delivery tube increases the stability of atomization process.

## 4. References

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