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Study of Water Jets Collision of High Pressure Flat Jet Nozzles for Hydraulic Descaling

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Abstract: One of the most effective methods for descaling hot-rolled steel products is performed using high pressure flat jet nozzles. These descaling nozzles are arranged in rows in hot rolling mills and are set in such a way that each adjoining pair of nozzles creates an overlapping area of water jet streams. Good homogeneity of the pressure distribution over the width of the hot-rolled plate is often used as an indicator of quality of the homogeneity of descaling. The presented laboratory measurements examine one pair of adjoining nozzles with a particular focus on the pressure distribution in the overlapping area. This paper deals with one particular setting of a pair of descaling nozzles with zero offset angles for the jet streams. A measured pressure distribution and an outcome of an erosion test on an aluminum plate are presented and discussed. The erosion test shows that spots with higher pressures do not necessarily result in a higher amount of taken material during an erosion test. The erosion test differs from the expected outcome in such a way as to warrant a detailed discussion of this phenomenon with possible explanations outlined.

Introduction

Steel production is indivisible from very hot surfaces in many cases. Hot steel reacts with oxygen in the surrounding atmosphere and unwanted scales are formed on the surface. Hydraulic descaling using high pressure flat jet nozzles is very effective for removing these scales. A row of nozzles must be used for larger products. This paper explores the overlapping area where water from two adjoining nozzles interacts due to the zero offset angles. Tested configuration was as follows: EVERLOY DNM04835 nozzle type, 55 mm spray height, 43 mm nozzle pitch, 40 MPa water pressure, 15° inclination angle, 0° offset angle. The pressure distribution measurement and erosion test are commonly used for descaling nozzle efficiency studies. However, it was found that the pressure distribution may not be in accordance with erosion tests.

A pressure distribution measurement was performed on a flat test plate equipped with a pressure sensor with 1 mm in diameter. The sensor moves in the X/Y direction under spraying nozzles and measures the position-dependent pressure. The measured data is slightly blurred due to the nonzero size of the sensor. The outcomes of the pressure experiments are presented in Fig. 1. It includes the pressure distribution for nozzles measured separately, together and with the algebraic sum from single sprays.

An erosion test was performed on an aluminum plate (A1050). The plate was exposed to the water jet streams for 10 seconds. Part of the aluminum was sprayed away and a hole in the plate was created due to the high impact of water. A 3D scan was done to obtain a computer model of the excavated hole. The maximum depth of the hole was taken in the dimension perpendicular to the length. A similar maximum was taken for the pressure distribution. Both maxima are compared in Fig. 2.

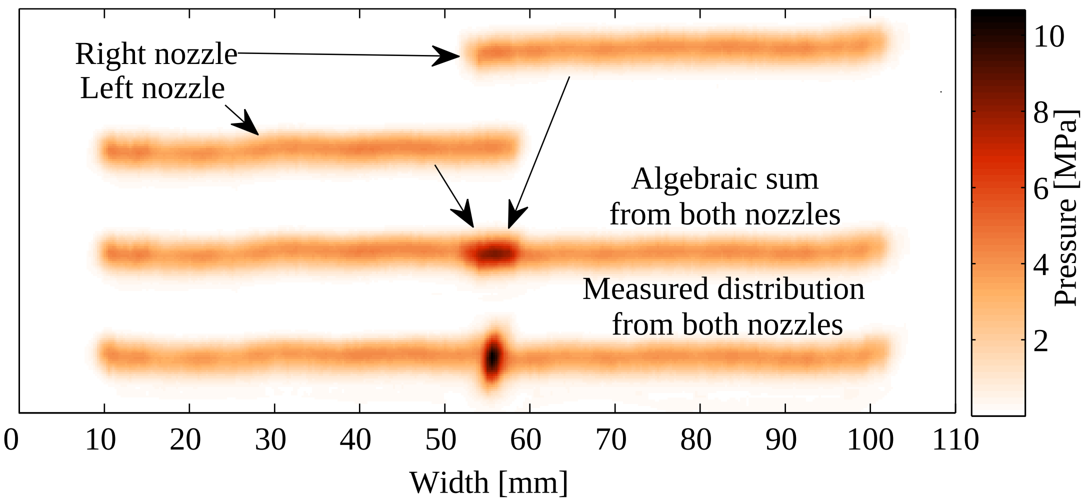

Fig. 1: Pressure distributions of the nozzles

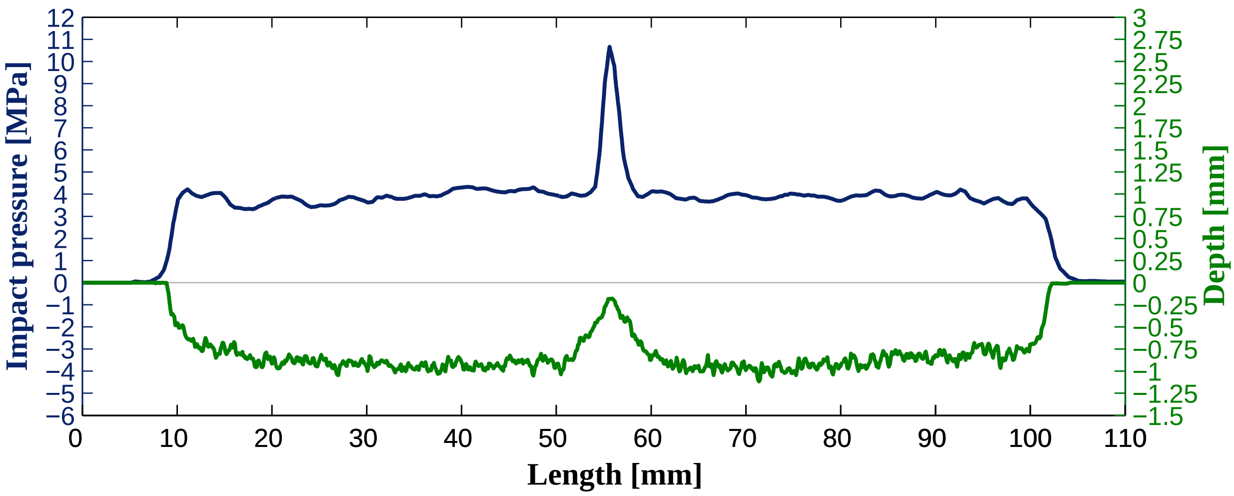

Fig. 2: Pressure distribution vs. erosion test

Conclusion

The pressure distribution change in the overlapping area is evident. Impacting water creates higher pressure in the middle of the overlapping area than what could be expected just from the algebraic sum from single sprays. Whereas the maximum pressure of the algebraic sum is 8.4 MPa, the maximum pressure of the adjoining configuration is 10.66 MPa. Although the pressure in the overlapping area reaches its maximum, the erosion for the same position is minimal. An important observation is that the erosion test reflects only the mechanical effect of the descaling and does not say anything about the thermal effects on the scales. This indicates a substantial change of the character of the stream and supports the statement in [1] that "pressure is not a measure of descaling effectiveness".

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