Enhanced accuracy of descaling nozzle arrangements with new, complementary measurement methods

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Abstract
Stricter environmental legislations and rising energy costs force metallurgical plant builders and steel producers to constantly increase their energy and resource efficiency.
Consequently hydro mechanical descaling systems need to be designed in such way that the conventional high safety margins resulting in excessive spray overlaps must be eliminated. Latest technologies have been applied to the new measurements of all variables which form the basis for the new edition of the DESCALE 7.5 software which is an indispensable tool for the design of descaling headers. In order to verify these digital values under a more practical approach, two additional and complementary methods have been utilised which will also be discussed in the paper. Both methods, the aluminium erosion method and the new hot descaling test, the latter representing real conditions, have a very high degree of agreement of the values and the results. Details of all three methods and the results will be discussed.

New impact measurement
Descaling system revamp projects are often driven by the need to improve the surface quality of the rolled products. Not only in these cases, but also for newly designed systems, the optimisation of the spray nozzle arrangement is always in the focus of the designer. Here the impact and in particular the spray width values play a major role, and are now required with a much higher accuracy than ever before.
With spray thicknesses now ranging between only 3 and 5mm at spray heights often below 100mm and descaling nozzles sizes becoming smaller and smaller, a 1mm diameter sensor (force transducers) has been chosen to provide the required resolution (Fig.1). Without this new high resolution technology (Lechler HiRes) and it's much higher accuracy, the development of the latest Lechler Scalemaster HP Superior® descaling nozzle generation would not have been possible.

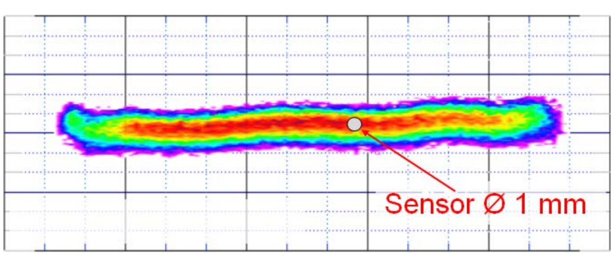

Fig.1: Sensor with 1mm dia. Over spray foot print

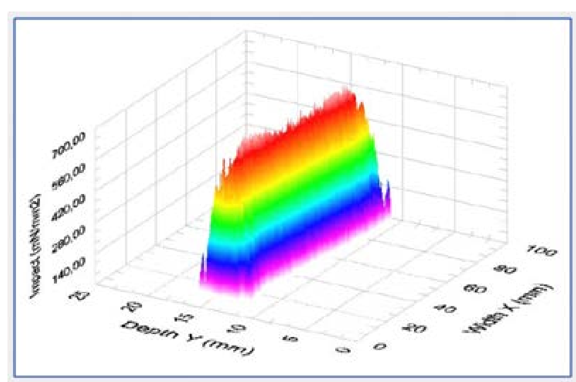

Fig.2: 3dimensional impact graph

When performing a measurement the sensor is moved under the spray at a specified spray height and scans the entire spray foot print along the scan path in one operation, as shown in figure 1. The sum of all the maximum impact value peaks on the centre line of the spray foot print and the quantity of peak impulses are required to calculate the Average max. Impact as shown in equation (1), this is an important value to describe the effectiveness of a descaling nozzle.

Equation (1): Av.max.Impact = 1/n $\sum$ max. Impactpeaks

New DESCALE 7.5 nozzle configuration soft ware

Soon after its first release in 1992, the PC based Lechler DESCALE software has without doubt become the most widely used tool in the design of thousands of descaling headers. It was to be expected that the impact, the spray width and the spray thickness values of a certain nozzle type at given spray conditions and measured with the conventional method would differ significantly from the values measured with the new HiRes technology. In parallel with the development of Lechler's new descaling nozzle generation Scalemaster HP Superior®, all previous Lechler descaling nozzle types had to be re-measured and new equations describing the impact characteristics had to be developed. With these data a new DESCALE software program was created allowing a comparison of all spray parameters of all nozzles acquired with the new HiRes method. Much higher prediction accuracy especially with respect to the spray overlaps was the result. In general, the impact values from the HiRes method are higher than those measured with the conventional method. Spray widths values at spray heights below 150mm tend to be smaller and at spray heights above 150mm they tend to be wider than before.
Moreover, for the first time descaling rings for rounds can be now configured; also the impact values for the utilisation of the Lechler WSV (Water Stop Valve) can be calculated with the new soft ware. The nozzle simulation shown in Fig. 3, which has been selected as the bench mark, resulted in a calculated effective spray width of 71mm at a spray height of 119mm, at 15° inclination angle and an offset angle of 15°.

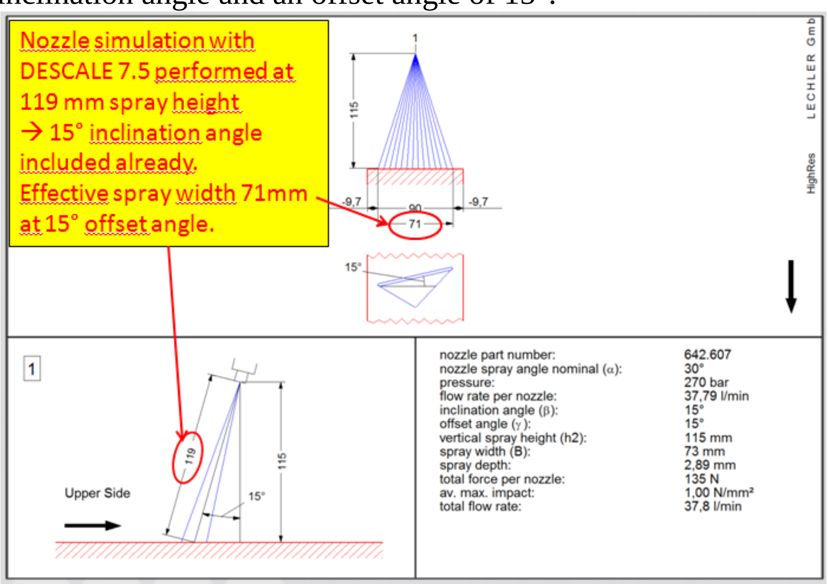

Fig. 3: Nozzle simulation with DESCALE 7.5

The values derived using the DESCALE 7.5 simulation had to be confirmed by an actual HiRes impact measurement for which the protocol is shown in Fig. 4. The measured spray width was 73,9mm (74mm) which results in an effective spray width of 71,4mm with an offset angle of 15°.

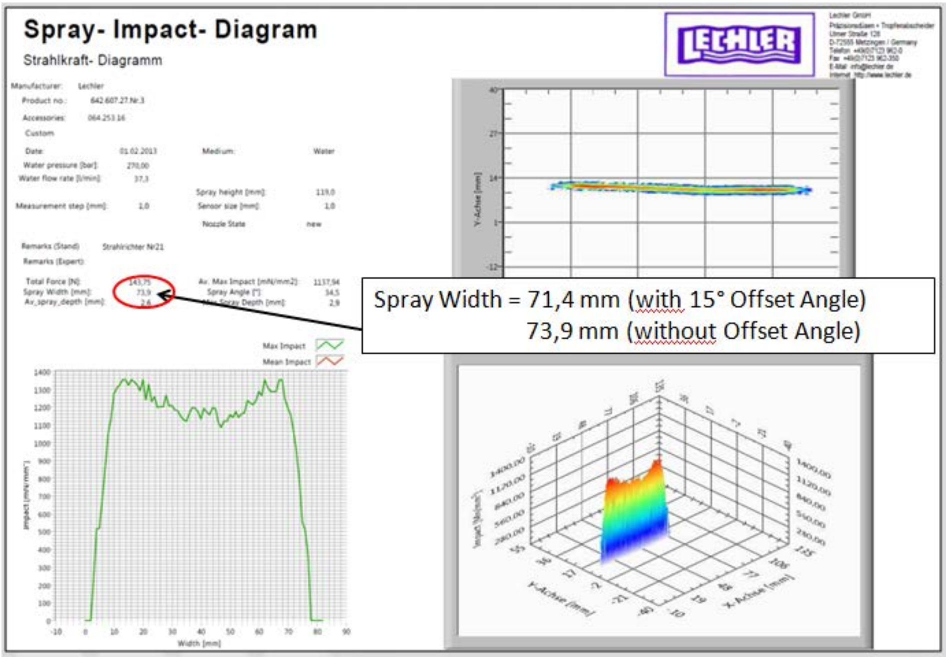

Fig. 4: Impact measurement protocol, 270bar and 119mm spray height

Aluminium Erosion Test

The so called aluminium erosion test method represents one method to verify in particular the spray width and the spray thickness. For this purpose the spray from a descaling nozzle is impacting onto an aluminium plate for a certain amount of time and at a given water pressure. The crater length which the high pressure water has eroded in the flat surface can easily be measured manually as shown in Fig. 5. The spray time was 15seconds at 270bar water pressure and the effective spray width at a 15° offset angle was 72,5mm for a verification of the calculation shown in Fig. 3. To perform the aluminium erosion tests however, either relatively high water pressures around and above 200 bar are necessary or spraying times of 15min and beyond for lower water pressures and smaller nozzles are required.

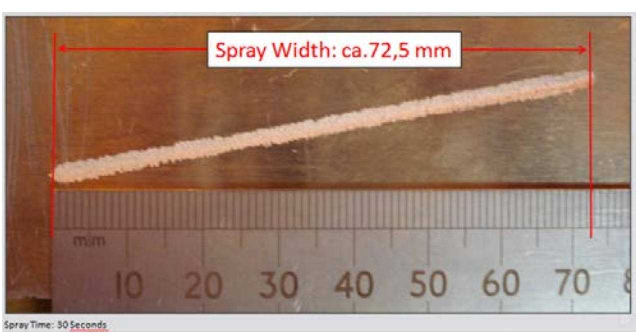

Fig. 5: Erosion crater seen from top with ruler.

Hot Descaling Test

Being aware of the fact that neither the HiRes Impact measurement and the subsequent simulation with the DESCALE 7.5, nor the aluminium erosion test method represent the real operation conditions in a hot rolling process; the need for a more realistic method became apparent. Ideal working conditions can be found the Swinden Technology Centre of Tata Steel. ,

Here not only a competent team of highly experienced researchers, but also a re-vamped facility for hot descaling tests including a high pressure pump, furnace and the possibility to set up reproducible test conditions are available.
A notablely difficult to descale electrical steel grade (SiMn) was chosen for the hot descaling verification test. The primary scale which was formed in the furnace at 1200°C was mainly Wusitite (Fig 6). Descaling took place with the same nozzle which had been utilised for the a.m. tests and under identical conditions; the speed was 0,25m/sec. The descaled area is visible as a broad, red band in Fig. 7. The nondescaled edge areas can clearly be distinguished from the descaled stripe.
The descaled stripe width was measured in cold condition with a ruler and was found to be approximately 69mm wide as can be seen in Fig. 8.


Fig. 6: Nondescaled steel sample

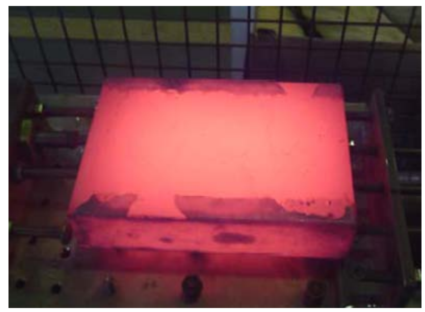
Fig. 7: Descaled steel sample

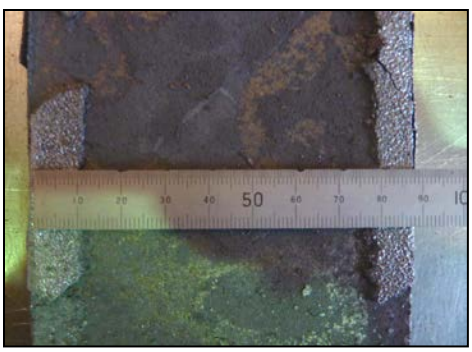
Fig. 8: Descaled stripe of 69mm width in cold condition

Conclusion and Outlook

With a predicted spray width of 70,5mm and a real descaled width of 69mm it has been proved that the Lechler DESCALE 7.5 is providing the user with a very high accuracy of data. The difference of 1,5mm was due to the rather indefinite and difficult to measure interface between the descaled and nondescaled areas. The accuracy was varified using the HiRes impact measurement method, which resulted in an effective spray width of 71,4mm. With the aluminium erosion test the effective spray width was 72,5mm. It is important to notice here, that both values are beyond the prediction of 70,5mm so that a certain safety margin is included even when narrow overlaps below 5mm are being chosen. Header configurations with a reduced number of nozzles and less water flows are now possible, especially when utilising the Scalemaster HP Superior®. This is one more step on the way to reducing energy consumption. Additional research activities are being targeted towards the investigation of the spray energy and to optimising the overlap area.