Summary of the doctoral thesis

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An impact of varying fluid conditions near the wall on heat transfer

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In heat exchangers and other devices as high efficiency as possible is of primary importance. It allows for heat exchange surface decreasing and consequently obtaining compact machine. It can be achieved by applying diverse techniques for heat transfer intensification. Herein mechanical aid technique constitutes the subject of the research. It consists in disturbing of thermal boundary layer by mechanical elements called scrapers. Despite the use of this technique for over 80 years, thermo-flow phenomena accompanying scraper movement are not fully understand so far. Moreover in the literature there is no systematized theory that enables heat transfer coefficient calculation with desirable accuracy.

In the current work state of the art on mechanical aid heat transfer is presented. Available mathematical models for heat transfer under periodically scraped thermal boundary layer are introduced and assumptions, which have been taken during their derivation, are critically discussed. The aim of the thesis was to experimentally and numerically verify available mathematical models and analyse an influence of the gap between the scraper tip and the wall surface on heat transfer.

In order to better understand transport phenomena during mechanical scraping of thermal boundary layer two- and three-dimensional numerical simulations were carried out. Two-dimensional studies were designed to identify factors that influence heat transfer predominantly during mechanical aid. Then elaborated numerical model was used to perform numerical simulations of heat transfer and fluid flow in three-dimensional space. Results were experimentally validated on the test stand which was designed and built for these reasons.

Results of the research showed that in the turbulent flow regime an influence of the gap on heat transfer is negligible. On the other hand in the laminar flow regime this factor plays a significant role and has to be taken into account during the analysis of heat transfer phenomena occurring under mechanical aid. Numerical and experimental results were compared with available in the literature mathematical models. It was shown that penetration theory model, which is most commonly used for heat transfer calculation purposes, yields highly erroneous results in the laminar flow regime.