CONTACTLESS HEAT TRANSFER MEASUREMENT METHODS IN PROCESSING UNITS

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Introduction

For a good design of the apparatus where heat exchange takes place, it is necessary to know very well the map of the intensity distribution of heat transfer in such apparatus. Despite the huge development of numerical simulations experimental measurement still has its place also due to the validation of these numerical models. Experimental technique is constantly evolving, thus improving experimentally measured results and also increasing the speed of measurement and decreasing financial demands.

Heat transfer measurement methods

Stationary methods - simple, accurate, often used by scientists, very time consuming, requires perfect insulation and precise reading of temperature and heat flux

Dynamic methods – fast, generally less accurate than stationary methods, based on response of the system to change, does not need perfect insulation

Comparative methods – based on the principle of similarity between heat and mass transfer

Aims of the work

Application of the oscillation method to complex flows – method has never been used for very complex flow such as vessel with agitators or else, very often seen in process engineering

Numerical and technical research of the oscillation method - focused on finding the limits of the method, practical implementation and synchronization methods, numerical analysis helped to find the minimum number of waves to minimize errors

Heat flux jump method – logical continuation, oscillation method is not very well suited for low values of heat transfer coefficient, changing the input function leads to a new measuring method that is directly targeted at this area

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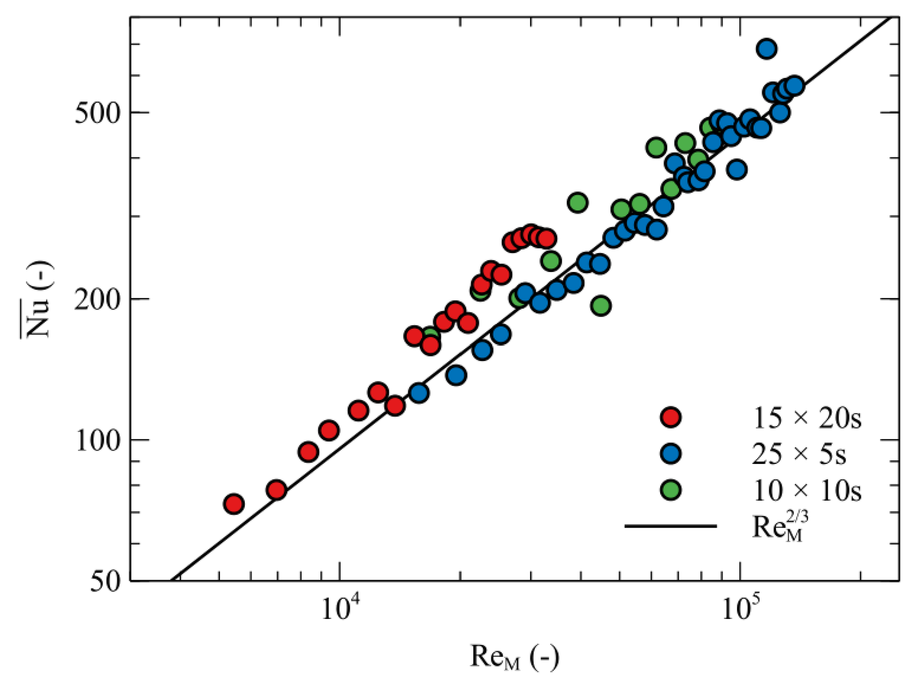
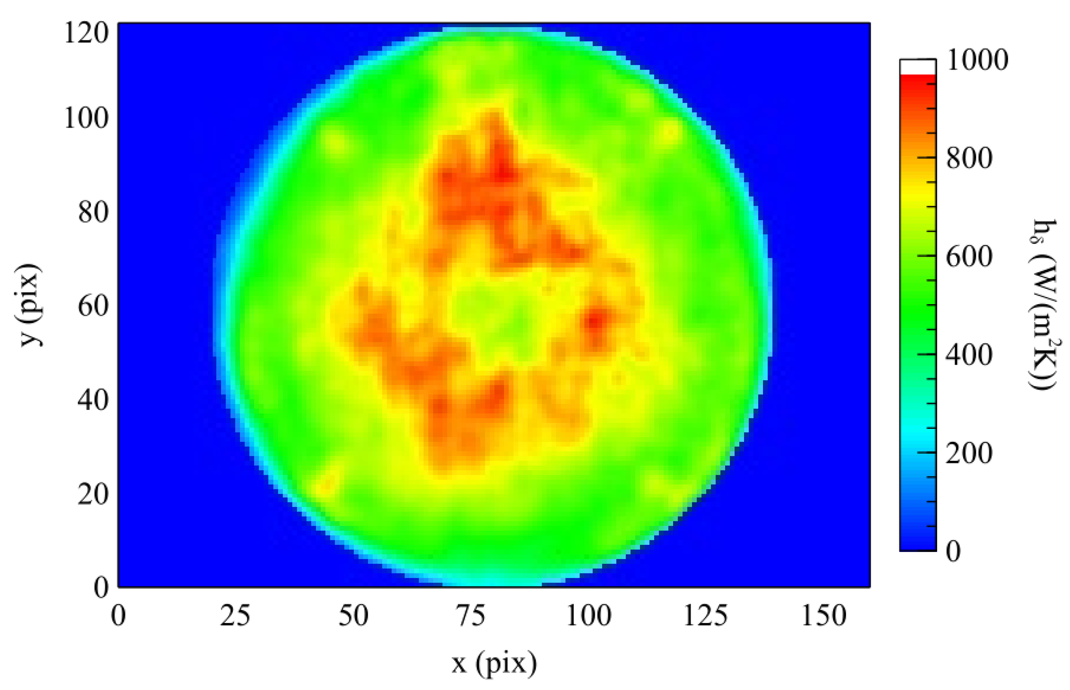
Temperature oscillation method

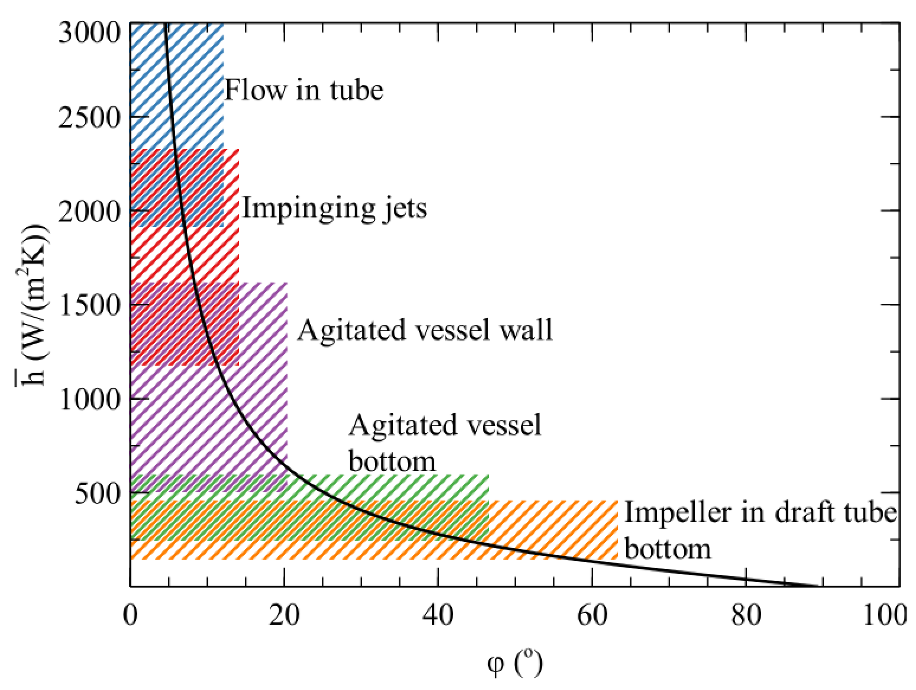
Application to very complex flow – overall Nusselt number for turbulent flow



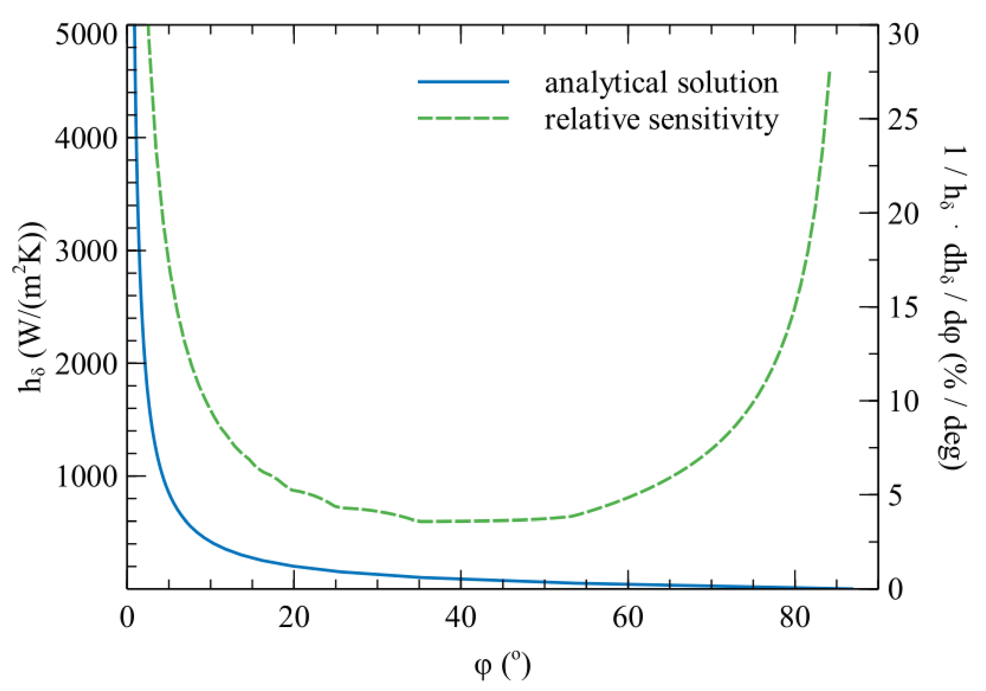
Bottom of vessel with axial impeller – local values of HTC



HTC interval for various experiments

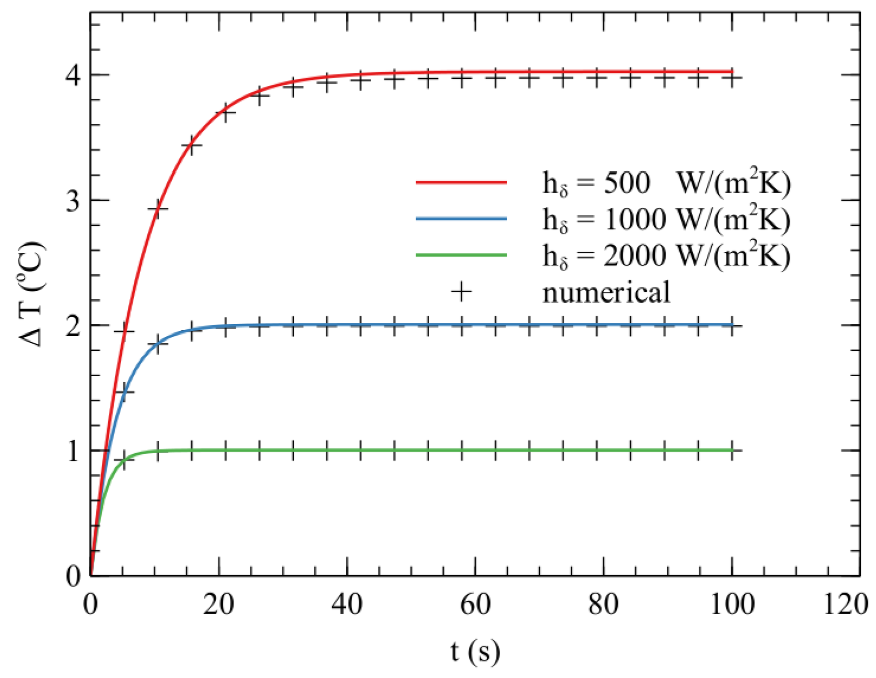


Relative sensitivity of oscillation method

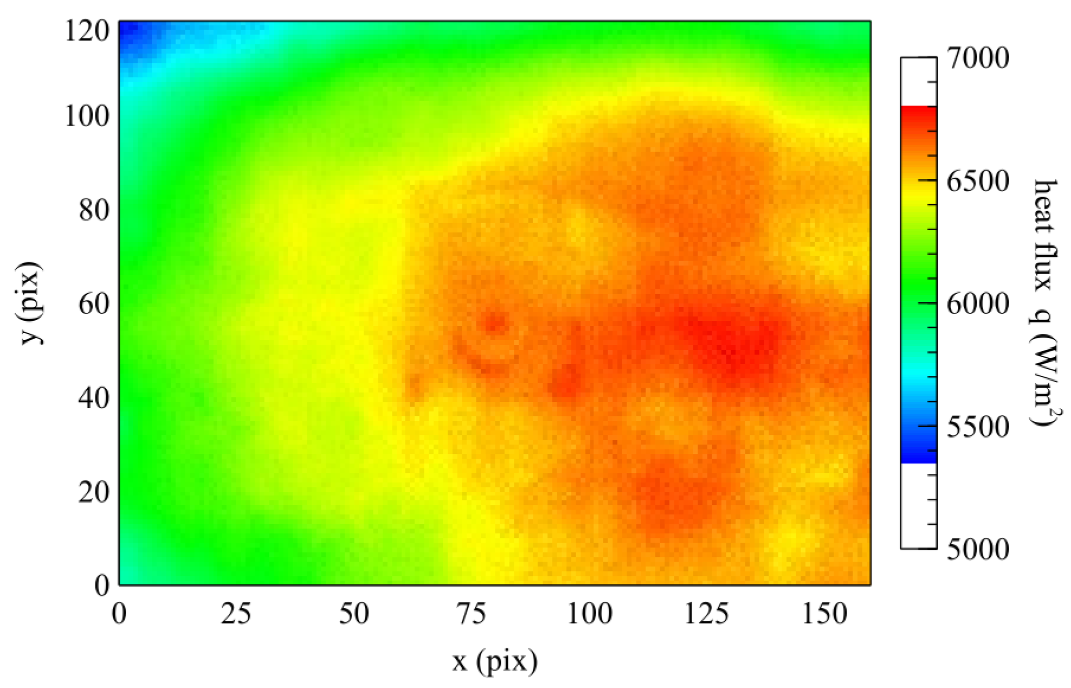


Heat flux jump method

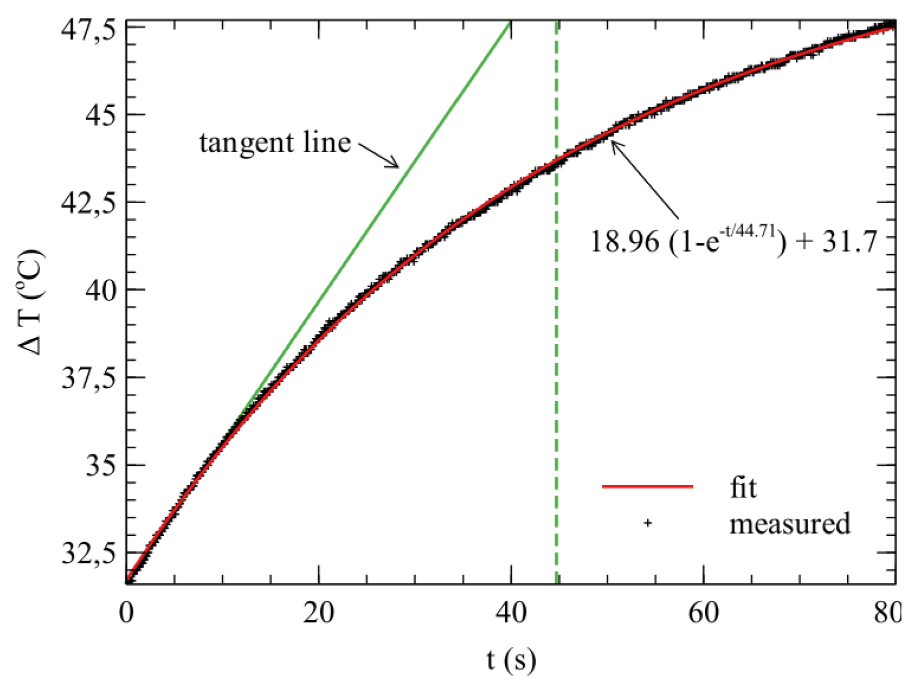
Numerical confirmation



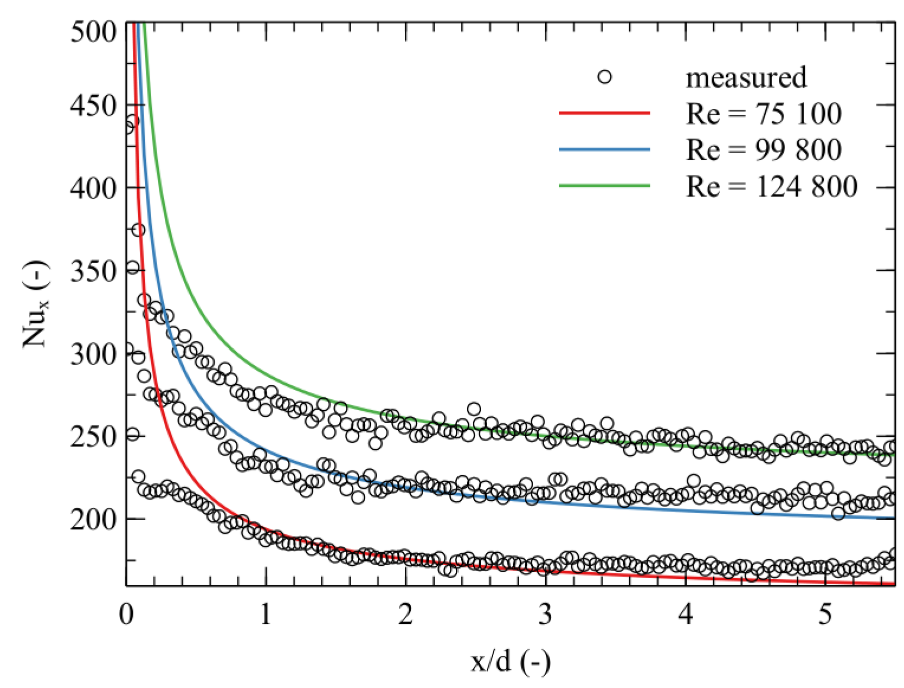
Methodology for local heat flux measurement



Data reduction – finding time constant



Experimental validation – Gnielinski with Hausen correction for short tube



Conclusion

- **oscillation method is applicable** to very complex flows, the bottom of the vessels with agitators **shows excellent results**, the wall of the stirred vessel **indicates problematic flow**, it is **not possible** to measure by the oscillation method
- **minimum number** of heat waves to minimize measurement error
- **new methods are prepared** for measuring the small heat transfer coefficient (mainly gas flows), analytically, numerically and experimentally verified
- **heat flux jump method** has a real application, the **impulse method** is rather theoretical
- **experimental** comparison with Gnielinski correlation with Hausen correction shows **very good results**, maximum error of total Nusselt numbers is **17%**, local values of Nusselt number show **minimal error**
- application of the method to **2D flow (plain wall and impinging jet)** also shows a minimal error, so the new method **is applicable to more complex flows**