Doctoral Thesis

Wandeffekte und Fehleranalyse bei der automatischen Messung von Grenzflächenspannungen mittels der maximalen Kraft-Methode

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WANDEFFEKTE UND FEHLERANALYSE BEI DER AUTOMATISCHEN
MESSUNG VON GRENZFLÄCHENSPANNUNGEN MITTELS DER
MAXIMALEN KRAFT-METHODE

ABHANDLUNG
zur Erlangung des Titels eines
Doktors der Technischen Wissenschaften
der
EIDGENÖSSISCHEN TECHNISCHEN HOCHSCHULE
ZUERICH
vorgelegt von
Rudy Heryanto Wilopo
Dipl.-Ing. der ETH Zürich
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Prof. Dr. W. Richarz, Korreferent

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SUMMARY

The method of determining surface and interfacial tensions of liquids by measuring the force acting on a solid measuring body as it is drawn out of the interface is well known and relatively simple to use.

In this work force balance equations and the solutions to the Young-Laplace equations have been used to determine the hydrostatic force acting on a body at the interface.

Special computer programmes based on this method have been developed from which the dimensionless force values for the given parameters corresponding to each body used in the measuring process have been reproduced in table form. From these tables it is now possible to determine the absolute values of surface and interfacial tensions for most of the liquid/liquid systems used in industrial chemical processes.

These tables are to be understood as an extension of the values published by other authors in respect to the most frequently used bodies, namely, vertical cylinders, cones and spheres, special consideration however being given to the predicting the influences of unideal environments on the measuring results.

Experience has shown that effects of the wall can only be determined at small distances from the wall, which indicates that this method can also be applied for measurements on liquids of smaller volumes, provided the wall effects are taken into consideration.

It has also been found that the use of spheres is of particular advantage, since the contact angle between the sphere and the interface can be determined by the Yarnold method which is especially suitable for automatic measurement.
To facilitate experimental procedures in the course of this work a fully automatic measuring apparatus, controlled by a laboratory computer was developed. Its special features include a step motor, an inductive force gauge and a Z-80 microprocessor which serves as a central calculating unit. With this apparatus a complete automation of the entire measuring procedure as also the evaluation of results can be achieved.

The experiments results are summarized in tables which also give the maximum error which can arise at specific conditions of a system. The results agree well with the literature values, since the errors lie within the limits of those calculated from the sensitivity analyses.