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Losses in alkali neutralization of edible oils

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SUMMARY

During the removal of free fatty acids from edible oils by extraction with a lye solution (i.e. alkali neutralization) considerable amounts of neutral oil are lost. These losses can only partly be accounted for by saponification and/or imperfect separation of the two phases after extraction. A previous investigation by Seip shows that there is a relation between the interfacial turbulence which occurs during this extraction process and these oil losses. His conclusion is that the losses are caused by spontaneous emulsification which is due to the occurrence of interfacial turbulence.

The present study has been initiated to check the validity of the above hypothesis and to investigate the (quantitative) relation between interfacial turbulence and oil losses, in particular the influence of several process parameters. In recent literature two possible mechanisms for spontaneous emulsification are given, notably: mechanical break-up of the interface due to interfacial turbulence and solution/dissolution from one phase into the other by transport of a third component across the interface ("diffusion and stranding"); for both cases a quantitative relation with the mass transfer process is given here.

In preliminary experiments in a so-called "stirred cell" the interfacial turbulence has been quantified by the enhancement factor for the mass transfer process. The enhancement factors measured are much higher (6 to 8) than might be expected on the basis of ordered interfacial turbulence or "roll-cells" (i.e. 2 to 3). At the same time oil losses have been determined as a function of the extraction time. From the combined results no correlation between enhancement factor and oil losses can be derived. It appears that the relative oil losses, i.e. the oil losses divided by the amount of fatty acid extracted, are almost constant, which indicates that probably the "diffusion and stranding" mechanism is responsible for the spontaneous emulsification and consequently for the oil losses. This result makes a new analysis of this extraction process necessary, particularly of the interfacial behaviour.

The semi-quantitative analysis which follows, shows that when the critical micelle concentration (C.M.C.) is exceeded, the aggregation process of the soap formed during the extraction is essential in the equalization of the soap concentration in the water phase. It can be demonstrated that this aggregation process to micelles takes place in the interfacial layer and gives rise to local higher adsorption of (aggregated) soap at the interface. The model postulated here assumes that as a result of increased adsorption interfacial tension differences occur which may cause turbulence. Moreover it is assumed that during aggregation in the interfacial layer oil can be

included leading to losses. The latter process will be analogous to the solubilization process occurring in the case of fatty acid soaps (and other surfactants). Using this analogy a quantitative relation has been given for the oil losses, the solubilizing power of the fatty acid soap being mainly determinative. With this quantitative model for describing the oil losses the results mentioned previously can be understood. At the same time the validity has been demonstrated in further - model experiments in which essential parameters such as type of fatty acid, temperature lye and ionic strength have been investigated. An exception is the influence of the temperature which is much stronger than would be expected on the basis of solubilization data. This points to the apparent formation of more structured aggregates than the micelles mentioned.

Finally in a general discussion it is shown that Seip's results fit the quantitative model very well, whereas at the same time the limited available data on practical results can be understood on the basis of the model.

The final conclusion therefore is that the model of aggregation of soap molecules at the interface describes the oil losses adequately. The influence of temperature, which points in the direction of more complex aggregates than micelles, demands further research.