

## Memo

To: U. R. A. Loser

From: I. M. Knot

CC: R. Boss

Date: 8/28/08

Subject: Your under-performing reactor

R. Boss told me about your new reactor and the low rate you are experiencing. She asked me to look over your data and see whether I could discern a reason. The reaction in question involves a liquid with negligible vapor pressure and a gas with negligible solubility as reactants. Under these circumstances, the only place reaction will take place is at the interface between these two phases. When you computed the rate, you normalized it to the volume of the reactor. A better choice would have been to normalize it to the interfacial surface area.

If your goal was to increase the rate ten-fold, then you needed to increase the interfacial surface area, not the reactor volume, by a factor of ten. While the reactor you specified does, indeed, have a volume that is ten times as large as the laboratory reactor, the interfacial surface area is only 4.7 times as large, as shown in the calculations below. If you had normalized the rate properly, you would have seen that the new reactor you designed would not meet specs.

I believe we can still use the reactor you ordered and installed, if we make a few modifications. One solution would be to add an aerator to the system so that the gas is taken from over the liquid and pumped to the bottom of the tank. If the gas is then expelled through a diffuser that causes small bubbles to form and rise back to the top, the interfacial area will increase. This will happen because the surface of each bubble will provide additional interfacial area. You'll just need to find the proper aeration rate and diffuser size so that the rate increases sufficiently to meet specs.

Calculations:

The original reactor's interfacial surface area :  $A_{original} = \frac{\pi D_{original}^2}{4} = 78.5 \text{ cm}^2$

The new reactor's interfacial surface area:  $A_{new} = \frac{\pi D_{new}^2}{4} = 366 \text{ cm}^2$

Ratio of new reactor's interfacial surface area to that of the old reactor: 4.7

Ratio of rate in new reactor to that in original reactor: 4.7