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ANALYTICS	HUMAN EFFECTS	ANIMAL TOXICITY	WORKPLACE PRACTICES-ENGINEERING CONTROLS	MISCELLANEOUS

SECONDARY SUBJECT HEADINGS: AN HU AT IH M

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- Biological Monitoring
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- Treatment
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30-10 Bacterial Lethality Predictions During Heating Based on Principles of Similitude

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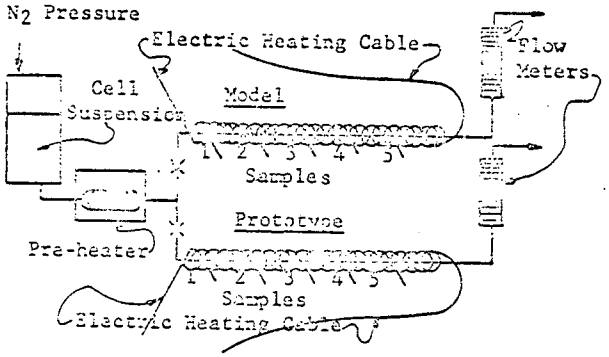
The present method of predicting the number of bacterial cell survivors in biological suspensions depends upon knowledge of the thermal inactivation kinetics of the most heat resistant bacteria present in the suspension, and the time-temperature history of the suspension(1). This method is deficient because it assumes first order thermal inactivation kinetics; and it does not recognize effects of transient(2) conditions prior to isothermal heating on the kinetics used to calculate the predictions. Therefore, a continuous flow laboratory scale-up method has been developed based on principles of chemical similitude(3) which does not depend upon first order kinetics and which takes into account transient effects.

Method. A specially designed apparatus (Figure 1) was constructed based on equality of the Damkohler group, rL/uC, where r is the reaction rate, L is the length, u is the linear velocity, and C the concentration. The apparatus consisted of stainless steel superpressure tubing connected from a high pressure nitrogen gas cylinder to an ice-jacketed stainless steel tank, and from the tank to the reactors or heat exchangers (the prototype and the model). In keeping with the Damkohler group, the prototype was made from a length of 40-inch tubing (Type 304 stainless steel) with a 1/4-inch inside diameter and a 3/8-inch outside diameter; whereas the model was made from a length of 40-inch tubing with a 1/8-inch inside diameter and 1/4-inch outside diameter. In this choice the radii of the prototype and the model were in the ratio of 2. The flow rate was regulated by the pressure and was measured with a triflat variable area flow meter. The temperature measuring system consisted of a temperature recorder and the thermocouples which were inserted inside the tubing. The samples were taken at the centerline of the fluid with hypodermic needle and stopcock assemblies which were placed through the wall of the reactors. The apparatus was, therefore, such a design that the different locations from which the samples were taken represented different residence or reaction times.



Application. Lethality predictions in the prototype were based on experiments with the model and then the predictions were experimentally verified by microbiological assay of the through-put in the prototype. The test organism was a 10^8 cell per ml. suspension of Salmonella senftenberg 775W propagated and assayed according to Licciardello and Nickerson(4). Under a specific flow rate, two complete replications were performed at 65.6°C and one replication at 68.3°C. After steady state flow and temperature conditions were achieved, samples were taken by ejecting them into a pre-cooled test tube which contained 24 glass beads 3 mm in diameter. One-tenth ml. portions of the appropriate dilutions were surface plated on tripticase soy agar in triplicate. The results appear in Table I.

Table I

°C	cc/min.	F, Regression Analysis	Linear Regression
65.6	40	452.38*	log Y = 7.8218 -0.1101X
65.6	10	322.82*	log Y = 7.8790 -0.1163X
68.3	40	267.67*	log Y = 7.5525 -0.2488X
68.3	10	222.68*	log Y = 7.0501 -0.2596X

*1% level of significance

Discussion. Lethality predictions in the prototype based on performance of the model, and experimentally verified, agreed at the 1% level of significance for a scale-up of 2 based on diameters of the reactors and a scale-up of 4 based on the flow rates used. It appears from these results that principles of chemical similitude can be applied to inactivation kinetics of cell suspensions. The advantage of this method lies in the fact that the inactivation kinetics of the organism need not be defined to make lethality predictions on a larger scale apparatus so long as the predictions are based on the equality of the Damkohler group.

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