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DISCUSSION

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Figure 11 compares the results reported in Morrow, Bass, and Lock's (MBL) paper for a guillotine rupture of an 8-in. LPG pipeline with models developed by Hans. K. Fauske and Associates and by L. H. Teuscher and J. Sabnis of Energy Resource Co., Inc. Two classes of models are represented, distributed (multinode) and lumped (single node). Multinode models break the pipe length into discrete lengths (10 in the present example) and apply equations describing conservation of mass, momentum, and energy for each length (node) in a coupled, sequential manner to approximate the distributed nature of the pipeline. Using Fauske's notation, the 10-node, 2-phase models, assuming either homogeneous (no-slip) vapor, liquid flow (10n, IP, H) or allowing slip between vapor and liquid flow (10n, 2P, S), have nearly the same form of response as the MBL model. The distributed Fauske model predictions are below the MBL model prediction since Fauske predicts that subsonic flow is rapidly established.

Since single-node or lumped models have no pipeline length description, they are more appropriate for describing LPG storage vessel ruptures. The single node, 2-phase Fauske model with slip (1n, 2P, S) compares reasonably well with a model by Sabnis and Teuscher (S&T). The Sabnis and Teuscher model numerically solves the differential equations appropriate for a distributed system, but only for a short distance down the pipeline. This short-distance solution is then scaled to a longer pipeline to obtain the reported result. Another model for Sabnis and Teuscher, the BOX2P model, after an initial discharge of only liquid assumes only vapor phase release typical of gas blowdown models. This model agrees reasonably well with Fauske's single node, single-phase (all vapor) model (1n, 1P, V).

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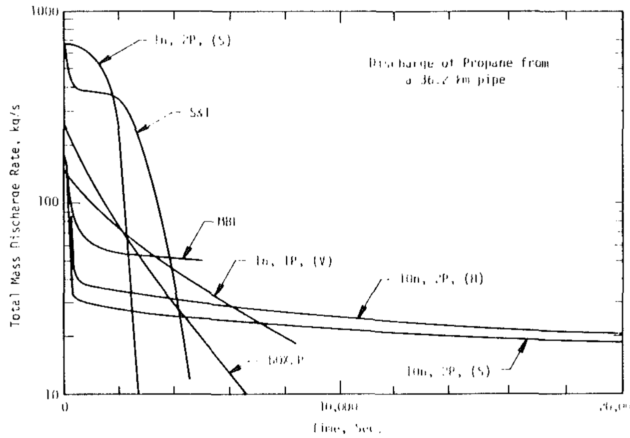

Fig. 11 *Comparison of discharge rate predictions for a guillotine rupture of an 8-in. LPG pipeline*

The figure shows that the initial response of single-node models does not drop off as fast as that of distributed models. However, the ultimate response of distributed models is more prolonged. This is a consequence of distributing the available internal energy of the pipeline fluid.

The Fauske single-node models have reportedly been substantiated by unpublished data from storage vessel rupture experiments. Experimental results for flashing liquid flow from ruptures of long pipelines are lacking.

Author's Closure

The authors are grateful to the reviewers for their constructive suggestions and comments. In particular, the comparison of predictions of pipeline discharge flowrate by our model with those of other models by Fauske, and Sabnis and Teuscher is especially appropriate. This comparison shows that more work is needed to improve the confidence in predictions of two-phase discharge flowrate from ruptured pipelines. Experimental data for flashing discharge from long pipelines in which friction effects are important is particularly needed to support improvements to the analytical models.

Recently the SwRI pipeline break flow model was improved by incorporating new models for LPG pool spreading and evaporation, and Colenbrander's [13] model for vapor cloud dispersion. Model assumptions restrict the application of this model to: 1) flat or mildly sloping terrain, 2) wind speeds of 2 m/s or higher, and 3) relatively unobstructed or rural terrain. Predictions of flammable vapor cloud boundaries were compared with information obtained from a selected set of official pipeline accident reports for which the model could be applied. In general, the agreement was good and we hope to report the results in the future.