ABSTRACT

Packing and drafting natural gas pipelines are important in the design of gas pipeline systems, during the daily operation of gas supply to meet expected demand levels and as a tool for trouble-shooting anomalous pipeline pressure behaviour. The aim of this report is to examine the applicability of the explicit method for solving the equations governing transient gas pipeline behaviour. The two partial differential equations for transient pipeline gas flow were discretised and the resulting finite difference equations put into explicit form.

The method was coded into a computer program and run on a PDP 11/34 digital computer. Four boundary conditions, two for pack and two for draft were solved using a time increment of 0.001 dimensionless time and a dimensionless pipe segment size of 0.00505. Computation time was approximately fifty-five (55) minutes to a total dimensionless time of fifty-five (55). The only stable numerical method found was a mixed forward - backward difference scheme. The mass flow rate equation uses forward differences while the pressure equation uses backward differences.

The results of the simulations were compared to the work of Nelson and Powers with good agreement between the results of the present method and that of Nelson and Powers. A fast transient example presented by Streeter and Wylie compared favourably to a time of thirty (30) minutes when differences in results occurred. The present work's results were higher than that of Streeter and Wylie for times greater than thirty (30) minutes. Comparison to the results of de Nevers and Day for four boundary conditions gave good agreement for certain ratios of pressure to initial pressure and mass flow rate to initial mass flow rate.

An example for packing a pipeline is presented utilizing the results of de Nevers and Day, which yielded a maximum time for packing as forty (40) minutes while the results of the present work is thirty-four (34) minutes. This represents a difference of six (6) minutes or a deviation of 15%.

Previous solutions involved explicit schemes, method of characteristics and implicit techniques. A novel technique presented by Zhou et al uses steady-state equations in pipe segments to predict transient behaviour. Due to the lengthy computation time and restricted areas of comparison to solutions via implicit and method of characteristics techniques, it is recommended to use the explicit method only for small times and for slow transients.