ABSTRACT

Although comparisons of relative energy efficiency and cost effectiveness for small gas and mechanically pumped liquid overfeed refrigeration systems (arrangements) have been performed, no such comparison has been reported for large batch type ice-making systems. The ice-making plant at the Far East Vertical Shaft, East Rand Proprietary Mines (ERPM) Ltd, South Africa, which produced[1] ice in a batch-type process for cooling its underground workings, utilizes cold flash gas to pump liquid refrigerant to and through its ice-building evaporators. Each of this plant's three operating units manufactured up to 1000 tons of ice per day to adequately cool this gold mine's underground workings. For one unit of this plant, this investigation models the functioning of the existing 'cold gas' pumping arrangement, supported by test data. It then investigates, through similar modelling, a more conventional 'hot gas' pumping arrangement, and two possible mechanically pumped arrangements for this unit, functioning under similar conditions. The models provide a thermodynamically meaningful comparison of the different liquid overfeed refrigerant pumping arrangements, principally in terms of their energy efficiency and electrical cost effectiveness. They predict that under similar operating conditions, the current cold gas pumping arrangement is more energy efficient and electrically cost effective than both hot gas and *conventionally* mechanically pumped arrangements. This agrees with the suggestions and conclusions of previous investigations performed on smaller refrigeration systems. However, compared to a theoretical *fully* mechanically pumped arrangement, the existing cold gas pumped system is predicted to incur larger unproductive refrigeration demand and higher annual electrical operating cost.

[1] Underground operations at the mine were suspended on 31 October 2008.