Introduction

The energy crisis has focused a tremendous amount of attention on systems for transporting raw energy sources such as natural gas from areas where it is plentiful to those in which it is scarce. One of the principal responses to this problem has been worldwide shipboard transportation of the natural gas in liquefied form in which it occupies only about 1/600 of the space as when it is in gaseous form. The boiling point of natural gas is −160°C (−260°F), and it must be maintained at that temperature or below while it is transported from place to place in liquefied form.

The critical nature of the containment of such large energy sources plus the requirements for (*a*) extremely large capacity, and (*b*) high resistance to fracture at very low temperatures have challenged the materials industry. A considerable amount of effort has been devoted in recent years to the evaluation of prime candidate tankage materials to determine the degree to which they may reliably be used in such critical service. It is the purpose of this volume to provide a current and comprehensive review of the work that has been done throughout the world. Representation from Norway, Sweden, England, Japan, and France, in addition to the United States, reflect the international breadth of the activity and the completeness of the coverage provided. The authorship represents consumers, materials producers, tank designers and builders, and code specification bodies, the full compliment of responsibilities in achieving high integrity structures. In fact, every known major contribution to work in this area is represented in this volume.

The first article in the volume is a survey of the industry problems and needs as seen by a representative of the gas suppliers. The second paper represents the codewriter's views of the designers responsibilities in dealing with structures containing real discontinuities such as those associated with welds, specifically for the spherical tank design of current interest at the present time because of its economy and simplicity.

The remaining articles are split into three general categories.

1. Those concerning aluminum alloys, predominately widely used aluminum-magnesium alloy 5083-0.

2. Studies of the nickel steels, primarily 9 percent nickel (9Ni) steel, for which there is considerable commercial experience, and also 5Ni steel, a relatively new entry into the field.

3. General articles on a variety of materials, aluminum, steel, and titanium.

The broad application in recent years of the Moss-Rosenburg spherical tank design also results in considerable attention in this volume to the fracture mechanics approach to the leak-before-break concept of tank design. This is notable for several reasons. First, it is probably the most important and critical use of fracture mechanics design outside of the aerospace industry. Secondly, in this application, fracture mechanics design must be applied to materials where final fracture seldom resembles the low ductility fracture (that is, with only very small amounts of plasticity relative to structure thickness) that is normally associated with the application of linear elastic fracture mechanics. As a result, these concepts are applied carefully and conservatively, with a large degree of cautious engineering judgment. The net result will be seen to combine the best efforts of both worlds: the conventional pressure vessel design coupled with conservative fracture mechanics design which should result in extremely high-integrity structures.

In summary, this volume contains a survey of the important engineering evaluations of the properties of all of the prime candidate materials for liquefied natural gas tankage today and is intended to include representation from all of the important experimental work going on throughout the world in a field where there is a unique combination of (*a*) critical safety and temperature requirements, (*b*) innovative designs, and (*c*) the latest in current evolution of property evaluation techniques.

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