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Problem Statement

This chapter outlines the research gaps and objectives of the thesis. The methodology adopted for this investigation is presented in the form of a flowchart.

3.1 RESEARCH GAPS

Based on the existing research, the following research gaps were identified:

- API 5L pipeline steel is prone to corrosive environments and complex stress states in service conditions. The welded sections, being non-homogeneous, are particularly vulnerable to these detrimental factors.
- Welding heat cycles resulting from multi-pass welding and the presence of inclusions adversely affect the crack resistance properties of the weldment.
- Further attention could be directed toward the development of SMAW electrode fluxes for pipeline steel welding, as these significantly influence weld bead properties.
- The effects of laboratory-developed fluxes on weld properties, such as mechanical behavior, metallurgical characteristics, and hydrogen effects, have yet to be fully explored.
- Ductile damage studies on welds using developed fluxes have not yet been performed. This can be addressed by estimating GTN model parameters and critical length parameters to predict the crack growth resistance of both the weld and the base metal.

3.2 RESEARCH OBJECTIVES

Following research objectives were planned for the present thesis work.

- Formulation of shielded metal arc welding electrode coatings for pipeline steels.
- Modeling and investigation of the thermophysical and physicochemical properties of flux, as well as high-temperature wettability analysis.
- Modeling and investigation of weld bead characteristics, such as weld chemistry and microhardness, based on bead-on-plate experiments.
- Characterization of the weldment through mechanical and metallurgical tests, including a study of the effects of hydrogen.
- Investigation of ductile fracture in the base metal and weld using finite element analysis with the Gurson-Tvergaard-Needleman model.

3.3 METHODOLOGY

