ABSTRACT

Steel contains iron with carbon addition upto 1.5% maximum which may be broadly classified into two types; plain carbon steel or carbon steel and alloy steel. Carbon steel contains iron, carbon, silicon and manganese without alloying elements whereas alloy steel is a steel containing iron, carbon with alloying elements such as nickel, chromium, molybdenum, cobalt, vanadium and tungsten. Steels used for structural purposes are called structural steels. Structural steel is construction material having certain standards of chemical composition and mechanical properties formed in specific shape or cross section. These steels are the default materials for industrial applications such as steel, aluminium, cement, fertilizers, oil and gas etc., infrastructure applications like power plants, transmission towers, bridges/flyovers and other applications like transport industry, plant equipment, railings etc. The consumption of steel in the world has been increasing continuously with present consumption of 1430 Mt (Year 2012) with expected increase by 3.1% to 1475 Mt in 2013. With the increase of demand; the approved methods for joining of these steels have become significant.

Submerged arc welding (SAW) is one of the preferred welding processes for above mentioned applications because of its inherent qualities like easy control of process variables, deep penetration, smooth finish, capability to weld thicker sections, prevention of atmospheric contamination of weld pool; leak proof joints and ease of automation (Parmar, 1992; Houldcroft, 1989; Murugan and Gunaraj, 2005; Khanna, 1999; Chai and Eagar, 1981; Gülenç and Kahraman, 2003). With the selection of SAW as welding process; other issues like the selection of suitable welding consumables and parameters for the joining of these steels must be in accordance with approved methods.
Among welding consumables flux is the main constituent and the fluxes for submerged arc welding of structural steels/high-strength low-alloy (HSLA) steels are not readily available; flux compositions are not clear and patented. In the present work attempt has been made at the design, development and optimization of flux for submerged arc welding of structural steel (API 5L X65). Twenty one agglomerated fluxes were formulated by using extreme vertices design suggested by McLean and Anderson. Experiments were conducted using the formulated fluxes at constant and optimum welding parameters. Optimum welding parameters were found separately by varying welding parameters using response surface methodology- central composite design (RSM-CCD). In the study; the effect of flux constituents on mechanical properties, chemical composition and microstructure of the weld metal has been studied. Regression models for ultimate tensile strength, percentage elongation, impact strength, microhardness and weld metal element content of welded specimens in terms of flux constituents have been developed. Developed regression models were checked for adequacy using t-test for individual regression coefficients and using ANOVA (F-Test) for whole regression equation. At the end of the work, optimum flux mixture compositions have been suggested to optimize these responses.