Second post-Newtonian approximation of scalar-tensor theory of gravity

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Deep space laser ranging missions like ASTROD I (Single-Spacecraft Astrodynamical Space Test of Relativity using Optical Devices) and ASTROD, together with astrometry missions like GAIA and LATOR will be able to test relativistic gravity to an unprecedented level of accuracy. More precisely, these missions will enable us to test relativistic gravity to 10^{-7}-10^{-9}, and will require 2nd post-Newtonian approximation of relevant theories of gravity. The first post-Newtonian approximation if valid to 10^{-6} and the second post-Newtonian is valid to 10^{-12}. The scalar-tensor theory is widely discussed and used in tests of relativistic gravity, especially after the interests in inflation and dark energy in cosmology. Here we present the full second post-Newtonian approximation of the scalar-tensor theory. We derive the metric coefficients and the equation of the hydrodynamics governing a perfect fluid in the 2nd post-Newtonian approximation in scalar-tensor theory; all terms inclusive of $O(c^{-4})$ are retained consistently in the equation of motion. The various conserved quantities to $O(c^{-4})$ are isolated with the aid of the energy-momentum complex in scalar-tensor theory.