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Individual Cylinder Ignition Advance Control Algorithms of the Aircraft Piston Engine

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Abstract : The impact of the ignition advance control algorithms of the ASz-62IR-16X aircraft piston engine on a combustion process has been presented in this paper. This aircraft engine is a nine-cylinder 1000 hp engine with a special electronic control ignition system. This engine has two spark plugs per cylinder with an ignition advance angle dependent on load and the rotational speed of the crankshaft. Accordingly, in most cases, these angles are not optimal for power generated. The scope of this paper is focused on developing algorithms to control the ignition advance angle in an electronic ignition control system of an engine. For this type of engine, i.e. radial engine, an ignition advance angle should be controlled independently for each cylinder because of the design of such an engine and its crankshaft system. The ignition advance angle is controlled in an open-loop way, which means that the control signal (i.e. ignition advance angle) is determined according to the previously developed maps, i.e. recorded tables of the correlation between the ignition advance angle and engine speed and load. Load can be measured by engine crankshaft speed or intake manifold pressure. Due to a limited memory of a controller, the impact of other independent variables (such as cylinder head temperature or knock) on the ignition advance angle is given as a series of one-dimensional arrays known as corrective characteristics. The value of the ignition advance angle specified combines the value calculated from the primary characteristics and several correction factors calculated from correction characteristics. Individual cylinder control can proceed in line with certain indicators determined from pressure registered in a combustion chamber. Control is assumed to be based on the following indicators: maximum pressure, maximum pressure angle, indicated mean effective pressure. Additionally, a knocking combustion indicator was defined. Individual control can be applied to a single set of spark plugs only, which results from two fundamental ideas behind designing a control system. Independent operation of two ignition control systems – if two control systems operate simultaneously. It is assumed that the entire individual control should be performed for a front spark plug only and a rear spark plug shall be controlled with a fixed (or specific) offset relative to the front one or from a reference map. The developed algorithms will be verified by simulation and engine test sand experiments. This work has been financed by the Polish National Centre for Research and Development, INNOLOT, under Grant Agreement No. INNOLOT/I/1/NCBR/2013.

Keywords : algorithm, combustion process, radial engine, spark plug

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