MEASUREMENT OF FLOW RATE CHARACTERISTICS DURING LOW-MELTING MATERIAL GASIFICATION IN A FLOW-THROUGH GAS GENERATOR

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Abstract: A technique is proposed for determining flow characteristics of a flow-through gas generator (GG) with the allocation of the flow rate created by gasification of a low-melting solid material in the total flow rate of gases leaving the GG. Experiments on the gasification of polypropylene samples in a flow-through GG with an approaching supersonic air flow heated in a fire heater were performed. The measured time-averaged mass flow rate of gasification products was 0.080 kg/s at the freestream Mach number $\mathrm{M} = 2.43$, 0.100 kg/s at $\mathrm{M} = 2.94$, and 0.050–0.020 kg/s at $\mathrm{M} = 3.81$. The ratio of the total mass flow rate of the incoming air to the total output of polypropylene gasification products was 1.61–2.86.

Keywords: flow-through gas generator; supersonic flow; polypropylene; gasification; flow rate

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Figure Captions

Figure 1 General view of the installation for testing the GG in the incoming supersonic flow: *1* — prechamber; *2* — fire heater; *3* — supersonic nozzle; *4* — air intake; *5* — igniter; *6* — GG; *7* — measuring nozzle; and *8* — exhaust tube

Figure 2 Schematic of the flow-through GG: *1* — air intake; *2* — igniter; *3* — stagnation temperature, $T_{0\mathrm{in}}$, measurement; *4* — stagnation pressure, $P_{0\mathrm{in}}$, measurement; *5* — test sample; *6* — measuring nozzle; *7* — stagnation pressure, $P_{0\mathrm{out}}$, measurement; *8* — stagnation temperature, $T_{0\mathrm{out}}$, measurement; *9* — static pressure, P_{out}, measurement; and *10* — nozzle throat

Figure 3 Block for assembling a test sample. Dimensions are in millimeters

Figure 4 Results of test fires at $\mathrm{M} = 2.43$: (*a*) test 1; (*b*) test 2; (*c*) test 3; *1* — P_0; *2* — $P_{0\mathrm{in}}$; *3* — $P_{0\mathrm{out}}$; *4* — P_{out}; *5* — T_0; *6* — $T_{0\mathrm{in}}$; and *7* — $T_{0\mathrm{out}}$

Figure 5 Results of test fires at $\mathrm{M} = 2.94$: (*a*) test 4; (*b*) test 5; (*c*) test 6; *1* — P_0; *2* — $P_{0\mathrm{in}}$; *3* — $P_{0\mathrm{out}}$; *4* — P_{out}; *5* — T_0; *6* — $T_{0\mathrm{in}}$; and *7* — $T_{0\mathrm{out}}$

Figure 6 Results of test fires at $\mathrm{M} = 3.81$: (*a*) test 7; (*b*) test 8; (*c*) test 9; *1* — P_0; *2* — $P_{0\mathrm{in}}$; *3* — $P_{0\mathrm{out}}$; *4* — P_{out}; *5* — T_0; *6* — $T_{0\mathrm{in}}$; and *7* — $T_{0\mathrm{out}}$

Figure 7 Unstart of the air intake during combustion: (*a*) test 3; (*b*) test 5; and (*c*) test 8

Figure 8 Coefficient m for calculating the mixture mass flow rate depending on the polypropylene-to-air mass ratio; $P = 1$ MPa

Figure 9 Processing of tests at $\mathrm{M} = 2.43$: (*a*) test 1; (*b*) test 2; (*c*) test 3; *1* — mass flow rate $G_{\mathrm{in}}(t)$; *2* — mass flow rate $G_{\mathrm{out}}(t)$; and *3* — $G_{\mathrm{out}}(t) - G_{\mathrm{in}}(t)$

Figure 10 Processing of experiments at $\mathrm{M} = 2.94$: (*a*) test 4; (*b*) test 5; (*c*) test 6; *1* — mass flow rate $G_{\mathrm{in}}(t)$; *2* — mass flow rate $G_{\mathrm{out}}(t)$; and *3* — $G_{\mathrm{out}}(t) - G_{\mathrm{in}}(t)$

Figure 11 Processing of experiments at $\mathrm{M} = 3.81$: (*a*) test 7; (*b*) test 8; (*c*) test 9; *1* — flow rate $G_{\mathrm{in}}(t)$; *2* — flow rate $G_{\mathrm{out}}(t)$; and *3* — $G_{\mathrm{out}}(t) - G_{\mathrm{in}}(t)$

Figure 12 Change in the mass of sample blocks in test 3: *1* — before test; and *2* — after test. Burning time $t_2 - t_1 = 3.46 - 1.15 = 2.31$ s

Figure 13 Photographs of sample blocks after test 3: (*a*) inlets; and (*b*) outlets

Table Captions

Table 1 Parameters of the air flow at the GG inlet

Table 2 Results of tests with combustion

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