AE 771 Combustion Design Project

Due: Wednesday April 1st, 2020

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Project Objectives

1. Designing a combustion chamber to connect to the conical and Rao nozzles.

2. Determining the frequencies of the first longitudinal, radial, and tangential modes for the combustor.

3. CAD model of the complete combustor-nozzle assemblies

4. Table of assumed and calculated values.

Code and Workflow

https://github.com/Drifterino/AE-771/blob/master/Design%20Project.ipynb

Assumed and Given Values

Symbol	Value	Variable	Units
F	10000	Thrust	Lbf
P1	1000	Chamber Pressure	Psia
MR	3.4	Mixture Ratio	Unitless
$\mathfrak{M}$	8.90	Molecular mass	lbm/lb-mol
T1	4380+459.67	Combustion Temperature	Rankine
K	1.26	Ratio of Specific Heats	unitless
P3	1.58	Ambient Pressure	psia
P2	P3	Optimum Operation Pressure	Psia
VCF	0.97	Velocity correction factor	unitless
TCF	0.98	Thrust correction factor	unitless
Go	32.2	Acceleration due to gravity	ft/s^2
Tp	152	Time of propulsion	Seconds
R	1544	Specific Gas Constant	ft·lbf·slug−1·°R−1
ρo	71.1	Liquid Weight Density of Oxygen (Oxidizer)	lbf/ft^3
ρf	4.4	Liquid Weight Density of Hydrogen (Fuel)	lbf/ft^3
SG	0.26	Specific Gravity	unitless

Combustion Chamber Values

Symbol	Value	Variable	Units
CCL	10	Combustion Chamber Length	inches
CDA	45	Convergence Duct Angle	degrees
CDL	2.2	Convergence Duct Length	inches
CDD	5.4	Combustion Duct Diameter	inches

Calculated Nozzle Values

Parameter	Ideal Value	Actual Value	Unit
Exit Velocity, V2	13890	13890	ft/sec
Throat Area, At	5.67	5.79	inch^2
Exit Area, A2	234.5	239.3	inch^2
Mach at Exit, M2	4.6	4.6	unitless
Total Weight Flowrate	23.2	24	lbf/sec
Oxidizer Weight Flowrate	17.93	18.55	lbf/sec
Fuel Weight Flowrate	5.27	5.45	lbf/sec
Total Propellant Weight	3526.68	3648	lbf
Total Oxidizer Weight	2725.16	2819	lbf
Total Fuel Weight	801.52	829	lbf
Oxidizer Volume Flowrate	0.25	0.26	ft^3/sec
Fuel Volume Flowrate	1.2	1.24	ft^3/sec
Total Oxidizer Volume	38.33	39.6	ft^3
Total Fuel Volume	182.16	188.4	ft^3

Resonance Frequencies

Symbol	Value	Variable	Unit
RFlong	617.125	1st Longitudinal Mode	Hz
RFrad	1147.976	1st Radial Mode	Hz
RFtan	365.412	1st Tangential Mode	Hz

CAD Models | Available on the GitHub as ConeHW8.prt and RaoHW8.prt