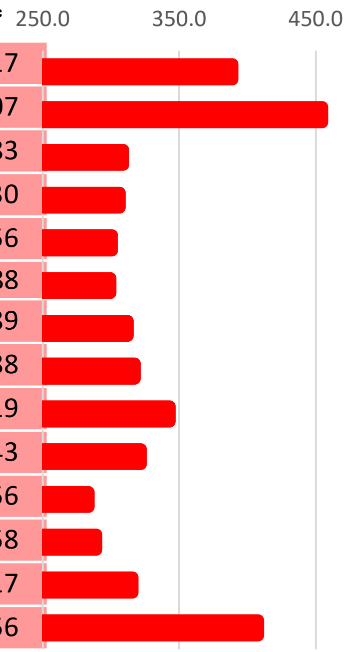
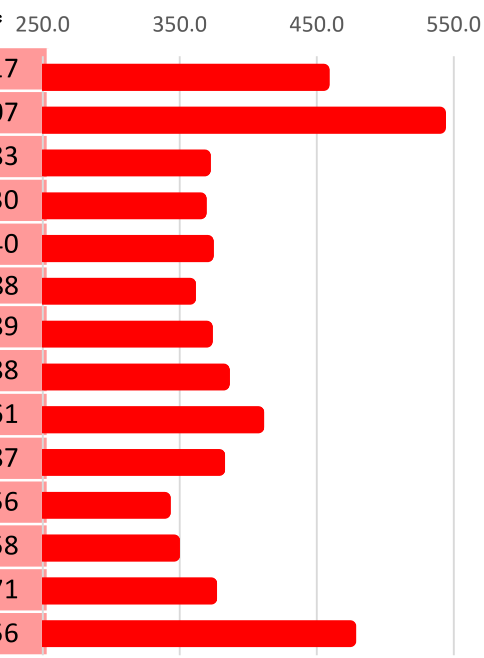
OPTIMUM EXPANSION, P_c = 1000 psia -> P_e = 14.7 psia

Oxidizer	Fuel	I_{opt}	r	T_c	d	C*
LOX	H_2	389.1	4.13	4938	0.29	7917
	H_2Be	454.9	0.87	4672	0.81	9207
	CH_4	309.2	3.21	5880	0.97	6083
	C_2H_6	306.4	2.89	5994	0.92	6030
	C_2H_4	300.8	2.38	6295	0.90	6056
	RP-1	299.6	2.58	6140	1.02	5888
	N_2H_4	312.4	0.93	5661	1.06	6189
	B_5H_9	317.7	2.12	6935	0.90	6188
	B_2H_6	343.2	1.96	6334	0.75	6719
	CH_4&H_2	321.9	3.36	5852	0.73	6343
	CH_3OH	283.9	1.36	5443	0.96	5556
	C_2H_5OH	289.3	1.80	5729	0.98	5658
GOX	CH_4	315.8	3.10	5922	0.00	6217
	GH_2	407.7	3.29	4653	0.00	8356



VACUUM EXPANSION, P_c = 1000 psia -> ε = 40

Oxidizer	Fuel	I_{vac}	r	T_c	d	C*
LOX	H_2	455.1	4.83	4957	0.32	7917
	H_2Be	540.1	0.91	4636	0.82	9207
	CH_4	368.5	3.45	5631	0.98	6083
	C_2H_6	365.5	3.10	5736	0.93	6030
	C_2H_4	370.6	2.59	6019	0.91	6140
	RP-1	357.7	2.77	5866	1.03	5888
	N_2H_4	369.9	0.98	5337	1.07	6189
	B_5H_9	382.3	2.16	6619	0.90	6188
	B_2H_6	407.5	2.06	6093	0.76	6661
	CH_4&H_2	379.1	3.63	5617	0.75	6287
	CH_3OH	339.3	1.40	5174	0.96	5556
	C_2H_5OH	346.1	1.90	5461	0.99	5658
GOX	CH_4	373.2	3.40	5592	0.00	6171
	GH_2	474.6	3.92	4179	0.00	8356



Percent Differences - Optimum Expansion

Oxidizer	Fuel	I_{opt}	r	T_c	d	C*
LOX	H_2	0.07%	-	0.53%	0.09%	0.13%
	H_2Be	0.90%	-	0.78%	253.35%	0.93%
	CH_4	0.15%	-	0.33%	18.42%	0.13%
	C_2H_6	0.09%	-	0.24%	1.90%	0.13%
	C_2H_4	3.44%	-	0.19%	1.90%	1.53%
	RP-1	0.16%	-	0.28%	0.57%	0.24%
	N_2H_4	0.06%	-	0.18%	1.54%	0.05%
	B_5H_9	0.36%	-	0.03%	2.44%	0.48%
	B_2H_6	0.37%	-	0.35%	1.14%	0.34%
	CH_4&H_2	0.90%	-	0.37%	2.85%	0.71%
	CH_3OH	0.08%	-	0.19%	0.15%	0.07%
	C_2H_5OH	0.07%	-	0.18%	0.59%	0.05%
GOX	CH_4	0.50%	-	0.57%	-	0.40%
	GH_2	0.05%	-	0.34%	-	0.12%

Percent Differences - Vacuum Expansion

Oxidizer	Fuel	I_{vac}	r	T_c	d	C*
LOX	H_2	0.05%	-	8.06%	9.45%	1.14%
	H_2Be	0.04%	-	1.19%	238.63%	1.53%
	CH_4	0.10%	-	5.43%	17.00%	0.88%
	C_2H_6	0.07%	-	5.41%	0.78%	0.74%
	C_2H_4	0.08%	-	5.50%	0.75%	0.90%
	RP-1	0.14%	-	5.43%	0.57%	0.65%
	N_2H_4	0.05%	-	6.08%	5.28%	0.57%
	B_5H_9	0.32%	-	5.24%	2.44%	0.43%
	B_2H_6	0.57%	-	5.46%	0.21%	0.42%
	CH_4&H_2	0.11%	-	5.58%	1.42%	1.01%
	CH_3OH	0.20%	-	5.30%	0.15%	0.20%
	C_2H_5OH	0.04%	-	5.17%	0.59%	0.55%
GOX	CH_4	0.35%	-	7.35%	-	0.88%
	GH_2	3.69%	-	19.39%	-	1.13%

OPTIMUM EXPANSION, P_c = 1000 psia -> P_e = 14.7 psia

Oxidizer	Fuel	I_{opt}	r	T_c	d	C*
LOX	H_2	389.1	4.13	4938	0.29	7917
	H_2Be	454.9	0.87	4672	0.81	9207
	CH_4	309.2	3.21	5880	0.97	6083
	C_2H_6	306.4	2.89	5994	0.92	6030
	C_2H_4	300.8	2.38	6295	0.90	6056
	RP-1	299.6	2.58	6140	1.02	5888
	N_2H_4	312.4	0.93	5661	1.06	6189
	B_5H_9	317.7	2.12	6935	0.90	6188
	B_2H_6	343.2	1.96	6334	0.75	6719
	CH_4&H_2	321.9	3.36	5852	0.73	6343
	CH_3OH	283.9	1.36	5443	0.96	5556
	C_2H_5OH	289.3	1.80	5729	0.98	5658
GOX	CH_4	315.8	3.10	5922	0.00	6217
	GH_2	407.7	3.29	4653	0.00	8356

VACUUM EXPANSION, P_c = 1000 psia -> ε = 40

Oxidizer	Fuel	I_{vac}	r	T_c	d	C*
LOX	H_2	455.1	4.83	4957	0.29	7917
	H_2Be	540.1	0.91	4636	0.81	9207
	CH_4	368.5	3.45	5631	0.97	6083
	C_2H_6	365.5	3.10	5736	0.92	6030
	C_2H_4	370.6	2.59	6019	0.90	6140
	RP-1	357.7	2.77	5866	1.02	5888
	N_2H_4	369.9	0.98	5337	1.06	6189
	B_5H_9	382.3	2.16	6619	0.90	6188
	B_2H_6	407.5	2.06	6093	0.75	6661
	CH_4&H_2	379.1	3.63	5617	0.73	6287
	CH_3OH	339.3	1.40	5174	0.96	5556
	C_2H_5OH	346.1	1.90	5461	0.98	5658
GOX	CH_4	373.2	3.40	5592	0.00	6171
	GH_2	474.6	3.92	4179	0.00	8356

optimum expansion, Pc = 1000 psia -> Pe = 14.7 psia

oxidizer	fuel	Iopt	r	Tc	d	C*
LOX	H2	389.4	4.13	4964	0.29	7927
	H2Be	459	0.87	4636	0.23	9293
	CH4	309.6	3.21	5900	0.82	6091
	C2H6	306.7	2.89	6008	0.9	6038
	C2H4	311.5	2.38	6307	0.88	6150
	RP-1	300.1	2.58	6157	1.03	5902
	N2H4	312.6	0.93	5671	1.08	6192
	B5H9	318.8	2.12	6933	0.92	6218
	B2H6	341.9	1.96	6312	0.74	6696
	CH4 H2	319	3.36	5873	0.71	6298
	CH3OH	284.1	1.36	5453	0.96	5560
	C2H5OH	289.5	1.8	5739	0.99	5661
GOX	CH4	314.2	3.1	5956	-	6192
	GH2	407.9	3.29	4669	-	8366

vacuum expansion, Pc = 1000 psia -> e = 40

oxidizer	fuel	Iopt	r	Tc	d	C*
LOX	H2	455.3	4.83	5392	0.32	7828
	H2Be	540.3	0.91	4692	0.24	9350
	CH4	368.9	3.45	5954	0.83	6030
	C2H6	365.7	3.1	6064	0.91	5986
	C2H4	370.9	2.59	6370	0.89	6085
	RP-1	358.2	2.77	6202	1.03	5850
	N2H4	370.1	0.98	5683	1.01	6154
	B5H9	383.5	2.16	6985	0.92	6215
	B2H6	409.8	2.06	6445	0.75	6689
	CH4 H2	379.5	3.63	5949	0.72	6224
	CH3OH	340	1.4	5464	0.96	5545
	C2H5OH	346.2	1.9	5759	0.99	5627
GOX	CH4	374.5	3.4	6036	-	6117
	GH2	457.7	3.92	5184	-	8263

This Homework Must Be Uploaded onto CANVAS to Receive Credit.
Deadline: Shown in Syllabus

Name: _Veronica Loomis_______________

Two-Page Annotated Bibliography Template

A. Summarize

Reference Document Examined:	Marsh, B. W. and Sears, G. A., "Introduction to the Analysis of Supersonic Ramjet Power Plants," American Rocket Society, Vol. 24, No. 3.
Reviewer:	Veronica Loomis
Source of Document:	Canvas
Date of Review:	March 22, 2023
Electronic File Name:	Introduction to the Analysis of Supersonic Ramjet Power Plants-1.pdf

Summary:

Ramjet diffusers are designed so that the total pressure lost is not as much lost by a single normal sock. Once this air has slowed to a high subsonic velocity, it is diffused to a low subsonic velocity. This air is burned in a combustion process that is at constant pressure. Expansion is performed in the nozzle exit and atmosphere behind the engine. The combustion takes place at constant static pressure with small total pressure losses.

The diffuser has a supersonic section and a subsonic section. The inlet geometry depends on the Mach number that the engine is designed for. A spike that projects outwards improves supersonic diffusion efficiency at higher Mach numbers.

B. Assess:

Important Facts from Document:

1. In supersonic ramjet diffusers, the inlets are designed so diffusion occurs through an oblique shock along with a normal shock.
2. The combination of oblique and normal shocks is desirable since the increase in entropy is less than one produced by a normal shock.
3. As air spillage increases, the flow into inlet becomes unstable and the normal shock oscillates rapidly axially.
4. The performance of ramjet engines are influenced by the quantity and efficiency of the heat the burner can release.
5. The main things that affect combustion are: incoming velocity, fuel to air ratio, combustion chamber pressure level, and total inlet stagnation temperature.

Key Figure from Document:

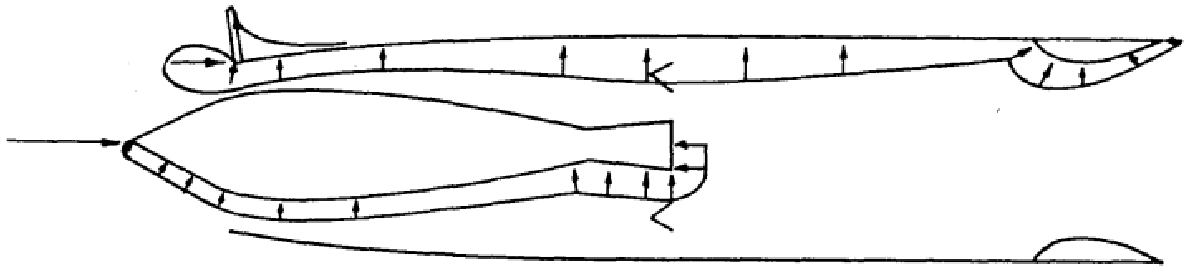


Figure 1: Pressure Distribution on Representative Ramjet Engine

Important Relationships among Parameters Described in the Paper:

1. Compression ratio and power output increase with speed.
2. Circular engines have the least drag per square foot of the frontal area compared to other cross-sectional shapes.

C. Reflect

This paper is really helpful in detailing each component of a ramjet engine and what its role is.