March 10/2021 RDE meeting material

part II: Results

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distribution limited to UW RDE group

3” RDE Distr A

* Results of internal flow structure analysis part 1;*b* =0, g=1.2.
* Two types found among b.p. insensitive runs
  + 19 out of 40 b.p. insensitive runs pt up-up type; pt decreases from front end to z=0.073, **increase**s from z=0.073 (m )to 0.086, **increase**s from 0.086 to 0.098
  + 21 out of 40 b.p. insensitive runs pt up-down type; pt decreases from front end to z=0.073, **increase**s from z=0.073 (m )to 0.086, **decrease**s from 0.086 to 0.098
* Pt increase/decrease is quantitively agree with the 1D cooling/heating effect; cooling pushes through the thermally choked flow to supersonic in both types. Up- up types have higher supersonic exit velocity (M=2.2 )than up-down types (M=1.9).
* pt up-up type average ISP 172 sec

pt. up-down type average 160 sec

b.p sensitive average ISP 160 sec

These are under investigation.

Comparison between all runs and exclusion of bp sensitive runs for 3 “ RDE Dist A

|  |  |
| --- | --- |
| All 42 runs | Excluding back pressure sensitive runs |
| dump tank pressure |  |
| Mix of up/down |  |
| Mix of up/down |  |
|  |  |

|  |  |
| --- | --- |
| all 42 runs | Excluding back pressure sensitive runs |
|  |  |
|  |  |
| For all runs | Excluding back pressure sensitive |
|  |  |

|  |  |
| --- | --- |
|  |  |

Near the annular end, two types of bp insensitive runs found:19 runs belonging to pt up / up, 21 runs belonging to pt up / down

|  |  |
| --- | --- |
| Pt Up-up type, excluding bp sensitive | Pt up down type, excluding bp sensitive |
|  |  |
|  |  |
|  |  |

Observations; between z=0.086 and 0.098

1. sonic between z=0.073 and 0.086
2. between z=0.086 and 0.098,sign of gradients of pt is opposite to those of Tt.
3. between z=0.086 and 0.098, M is supersonic and the sign of its gradients is opposite to those of Tt.

These are consistent with the following influence coefficients:





Quantitative comparison:



|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Pt up-up | | Pt up-down | |
| calculated | measured | calculated | measured |
| Between z=0.073 and 0.086 | 0.35 | 0.51 | 0.32 | 0.49 |
| Between z=0.086 and 0.098 | 0.27 | 0.31 | -0.12 | -0.12 |



|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Pt up-up | | Pt up-down | |
| calculated | measured | calculated | measured |
| Between z=0.073 and 0.086 | 0.58 | 1.42 | 0.56 | 0.87 |
| Between z=0.086 and 0.098 | 0.12 | 0.92 | -0.07 | -0.08 |



|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Pt up-up | | Pt up-down | |
| calculated | measured | calculated | measured |
| Between z=0.073 and 0.086 | -0.340 | -0.63 | -0.33 | -0.615 |
| Between z=0.086 and 0.098 | -0.036 | -0.061 | 0.026 | 0.037 |

|  |  |
| --- | --- |
| P for pt up-up type, excluding bp sensitive | P for pt up down type, excluding bp sensitive |
|  |  |
|  |  |

b.p. insenitive:

pt up-up type average ISP 172 sec

pt. up-down type average 160 se

b.p sensitive average ISP 160 sec



Smith & Stanley

**3” RDE Distr A SUMMARY**

All internal flow variables can be determined from mdot and CTAPS. No info for internal T is needed.

* Results of internal flow structure analysis
* Two types present among b.p. insensitive runs
* 19 out of 40 b.p. insensitive runs pt up-up type; pt decreases from front end to z=0.073, **increase**s from z=0.073 (m )to 0.086, **increase**s from 0.086 to 0.098
* 21 out of 40 b.p. insensitive runs pt up-down type; pt decreases from front end to z=0.073, **increase**s from z=0.073 (m )to 0.086, **decrease**s from 0.086 to 0.098

pt↓

pt↑↑

Pt up-down type



Pt up-up type



cooling

cooling

heating

pt↑↓

pt↓

* Pt increase/decrease is quantitively agree with the 1D cooling/heating effect; cooling pushes through the thermally choked flow to supersonic in both types. Up- up types have higher supersonic exit velocity (M=2.2 )than up-down types (M=1.9).
* pt up-up type average ISP 172 sec

pt. up-down type average 160 sec

b.p sensitive average ISP 160 sec

Q1: pathway of heat in/out transfer

Q2: why can supersonic flow near the end influence ISP? Under investigation

* Next Steps
* quantify b
* possible increase of Isp by cooling aft section?
* Does the space act as heat sink, increasing ISP?