Numerical study on optimal fluid settling management under microgravity

Binghong ZHOU*[1], Chunjun Wu[12], Qiang YU[1], Qiusheng LIU[3]

1 National Space Science Center. Chinese academy of sciences, Beijing. 100190. China

2 Graduate University of Chinese Academy of Sciences. Beijing, China

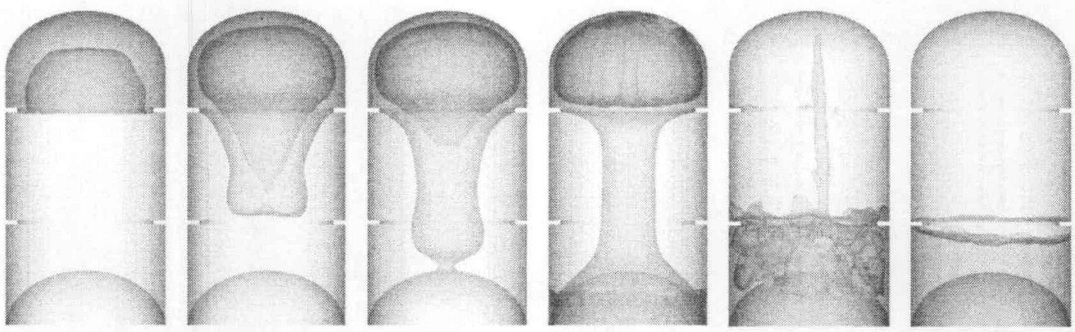
3 National Microgravity Laboratory, Institute of Mechanics, Chinese Academy of Sciences, China

Email address: bhzhou@nssc.ac.cn

A new space era has come, when the "dragon" spacecraft of SPACEX docking on ISS(international space station) and separated safely in May 2012. In this new space era, it is expected that more and more advanced technology will be used in space launch system. One advanced technology is optimal fluid settling management under microgravity. By use this kind of technology, the system weight could be reduced and microgravity coast period could be extended in order to adapt different space launch orbit.

However, the optimal use of propellant for the fluid settling management remains to be studied. For example, in the first two launch of Falcon-I, failure happened due to propellant slosh, which caused the upper stage out of control after separation from the first stage of the vehicle [1].

In this paper, we present our study on optimization of fluid management under microgravity environment. Numerical simulation is performed for the fluid/gas two-phase system in a propellant tank[2]. We find that using smaller settled propulsion will reduce propellant consumption when the Bond number lies within 100 to 400. In order to realize long time microgravity coast, a pulsed settling management method is recommended through numerical simulation.



a) t0=0s b) t1=0.45s c) t2=0.53s d) t3=0.65s e) t4=1.79s f) t5=3.90s

Figure 1: Propellant reorientation process in a scaled hydrogen tank
(fill rate is 20%,Bo=0 at t=0,Bo=200 during reorientation)

References

[1] Demo Flight 2- Flight Review Update. SpaceX Inc. 2007

[2] Jack A Salzman. Low-gravity reorientation in a scale-model Centaur liquid-hydrogen tank[R]. N 73-16252. NASA