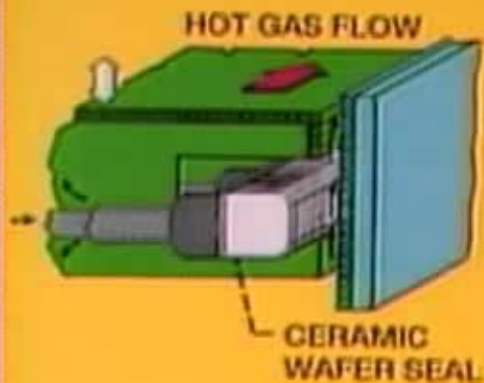
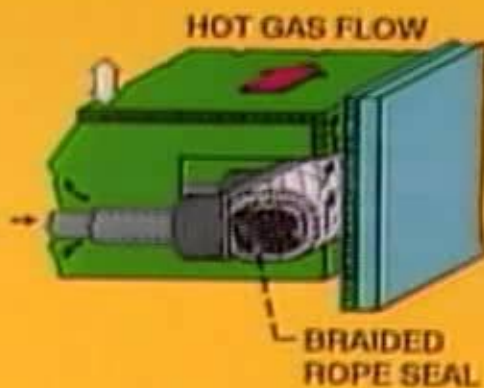


CERAMIC WAFER SEAL



BRAIDED CERAMIC ROPE SEAL



1
00:00:48,680 --> 00:00:45,710
NASA the National aerospace plane will

2
00:00:51,650 --> 00:00:48,690
launch horizontally fly directly into

3
00:00:55,360 --> 00:00:51,660
space complete its mission and land

4
00:00:58,270 --> 00:00:55,370
horizontally like the Space Shuttle

5
00:01:01,219 --> 00:00:58,280
advanced air-breathing ramjet scramjet

6
00:01:04,369 --> 00:01:01,229
engines being developed by a national

7
00:01:07,670 --> 00:01:04,379
team led by NASA and the Air Force will

8
00:01:12,020 --> 00:01:07,680
allow NASA to fly at up to 25 times the

9
00:01:13,850 --> 00:01:12,030
speed of sound because significant heat

10
00:01:17,060 --> 00:01:13,860
will be generated by the NASP s--

11
00:01:20,680 --> 00:01:17,070
tremendous speeds advanced engine and

12
00:01:23,570 --> 00:01:20,690
engine seal designs are necessary

13
00:01:26,359 --> 00:01:23,580

unlike rocket engines that carry large

14

00:01:29,149 --> 00:01:26,369

heavy oxygen tanks the air-breathing

15

00:01:31,870 --> 00:01:29,159

engines under development for the NASP

16

00:01:35,420 --> 00:01:31,880

extract oxygen from the air

17

00:01:38,120 --> 00:01:35,430

these engines will efficiently scoop and

18

00:01:41,930 --> 00:01:38,130

compress air to burn with the hydrogen

19

00:01:45,320 --> 00:01:41,940

fuel temperatures in the engine reach

20

00:01:47,480 --> 00:01:45,330

over 5,000 degrees Fahrenheit with

21

00:01:52,040 --> 00:01:47,490

pressures exceeding a hundred pounds per

22

00:01:54,410 --> 00:01:52,050

square inch to operate at speeds up to

23

00:01:57,050 --> 00:01:54,420

25 times the speed of a bullet

24

00:01:59,300 --> 00:01:57,060

the NASP engine must meter the

25

00:02:02,690 --> 00:01:59,310

combustion flow going through the engine

26

00:02:05,360 --> 00:02:02,700

duct much like your car's fuel valves

27

00:02:07,970 --> 00:02:05,370

the articulating nozzle panels in the

28

00:02:11,250 --> 00:02:07,980

NASP engine will tailor the flow for

29

00:02:17,550 --> 00:02:14,280

to prevent the hot potentially explosive

30

00:02:20,250 --> 00:02:17,560

combustion gases from escaping past the

31

00:02:24,470 --> 00:02:20,260

panels high-temperature seals are

32

00:02:27,300 --> 00:02:24,480

required around the panel's perimeters

33

00:02:30,059 --> 00:02:27,310

these seals must withstand extreme

34

00:02:33,420 --> 00:02:30,069

temperatures seal highly distorted

35

00:02:37,259 --> 00:02:33,430

sidewalls and resist abrasion over the

36

00:02:39,569 --> 00:02:37,269

life of the engine advance seal concepts

37

00:02:42,960 --> 00:02:39,579

are being developed at NASA's Lewis

38

00:02:45,660 --> 00:02:42,970

research center these seals are made of

39

00:02:48,420 --> 00:02:45,670

high-temperature ceramic materials able

40

00:02:52,349 --> 00:02:48,430

to operate at temperatures up to 2300

41

00:02:54,780 --> 00:02:52,359

degrees Fahrenheit above this some form

42

00:02:56,849 --> 00:02:54,790

of active cooling must be employed to

43

00:03:02,910 --> 00:02:56,859

stay within the operational limits of

44

00:03:05,280 --> 00:03:02,920

the material one leading concept under

45

00:03:08,069 --> 00:03:05,290

development is the ceramic wafer seal

46

00:03:10,770 --> 00:03:08,079

which consists of multiple ceramic

47

00:03:14,849 --> 00:03:10,780

wafers mounted in a channel of the

48

00:03:16,890 --> 00:03:14,859

articulating engine panel the seal

49

00:03:19,470 --> 00:03:16,900

accommodates and seals the large

50

00:03:22,409 --> 00:03:19,480

sidewall distortions through relative

51
00:03:27,449 --> 00:03:22,419
sliding of adjacent elements much like

52
00:03:30,960 --> 00:03:27,459
the behavior of a deck of cards another

53
00:03:32,400 --> 00:03:30,970
approach is the ceramic rope seal which

54
00:03:36,000 --> 00:03:32,410
is braided out of high-temperature

55
00:03:40,710 --> 00:03:36,010
ceramic fibers that maintain flexibility

56
00:03:43,379 --> 00:03:40,720
at temperature both seals are preloaded

57
00:03:46,740 --> 00:03:43,389
against the adjacent walls by a series

58
00:03:49,050 --> 00:03:46,750
of spring-like bellows the hot

59
00:03:51,449 --> 00:03:49,060
performance of the two seals were

60
00:03:54,030 --> 00:03:51,459
measured at NASA Lewis using the

61
00:03:56,699 --> 00:03:54,040
specially designed test fixture

62
00:03:59,520 --> 00:03:56,709
though one cannot see the seals in this

63
00:04:04,080 --> 00:03:59,530

picture the seals are mounted behind the

64

00:04:06,059 --> 00:04:04,090

front wall of the hot test rig tests

65

00:04:08,670 --> 00:04:06,069

have shown that the ceramic wafer seal

66

00:04:11,069 --> 00:04:08,680

has very low leakage even at

67

00:04:15,000 --> 00:04:11,079

temperatures exceeding 1,400 degrees

68

00:04:20,039 --> 00:04:15,010

Fahrenheit it seals both flat and

69

00:04:22,620 --> 00:04:20,049

distorted walls equally well tests of

70

00:04:25,350 --> 00:04:22,630

the braided ceramic rope seal identified

71

00:04:28,400 --> 00:04:25,360

key construction variables that can be

72

00:04:31,020 --> 00:04:28,410

optimized to meet the target flow goal

73

00:04:33,390 --> 00:04:31,030

high temperature seal technology

74

00:04:36,090 --> 00:04:33,400

developed under NASA is immediately

75

00:04:41,340 --> 00:04:36,100

beneficial to numerous aeronautical

76
00:04:43,379 --> 00:04:41,350
space and industrial applications high

77
00:04:45,540 --> 00:04:43,389
temperature seals will be required on

78
00:04:48,090 --> 00:04:45,550
advanced high-temperature combustors and

79
00:04:50,279 --> 00:04:48,100
nozzles being designed for future

80
00:04:54,420 --> 00:04:50,289
commercial and military supersonic

81
00:04:56,969 --> 00:04:54,430
aircraft NASA PI temperature seal

82
00:04:59,550 --> 00:04:56,979
technology can provide an extra margin

83
00:05:02,159 --> 00:04:59,560
of safety over the low-temperature o

84
00:05:06,330 --> 00:05:02,169
ring seals of the shuttles solid rocket

85
00:05:07,710 --> 00:05:06,340
motors and improve gap seals for the

86
00:05:10,560 --> 00:05:07,720
shuttles main engines

87
00:05:13,320 --> 00:05:10,570
the innovative seal work performed by

88
00:05:16,140 --> 00:05:13,330

NASA Lewis under the NASA program has

89

00:05:20,010 --> 00:05:16,150

earned four US patents over the last two

90

00:05:22,200 --> 00:05:20,020

years while R&D magazine recognized the

91

00:05:24,560 --> 00:05:22,210

ceramic wafer seal as one of the most

92

00:05:26,900 --> 00:05:24,570

significant new technical products of

93

00:05:30,890 --> 00:05:26,910

1990

94

00:05:33,620 --> 00:05:30,900

NASA the National aerospace plane is

95

00:05:36,200 --> 00:05:33,630

serving as a national focus for

96

00:05:38,620 --> 00:05:36,210

advancing the state-of-the-art in access