Rotor 11

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Original model

Rotor 11 is part of a research program to study the effect of weight flow per unit annulus area on the performance of axial-flow fan stages. A series of three stage: rotor 11, 16 and 17 were designed with a weight flow per unit annulus area of 198, 178, and 208 kilograms per second per square meter. All three stages were designed to produce a pressure ratio of 1.57, and all had the same meridional flow path geometry.

- Original technical report [(cite:kovich1973design>Kovich. «Performance of transonic fan stage with weight flow per unit annulus area of 198 kilograms per sercond per square meter (40.6 (lb/sec)/ft²) » 1973. pdf)]:

```
@TechReport{kovich1973design,
author      = {Kovich, George. and Moore, R. D. and Urasek, Donald C.},
title       = {Performance of transonic fan stage with weight flow per
unit annulus area of 198 kilograms per sercond per square meter (40.6
(lb/sec)/ft²)},
institution = {NASA Lewis Research Center Cleveland, OH, United States},
note        = {NASA-TM X-2905, url~:
\url{https://ntrs.nasa.gov/citations/19740001915}, 1973 }}
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- Picture :

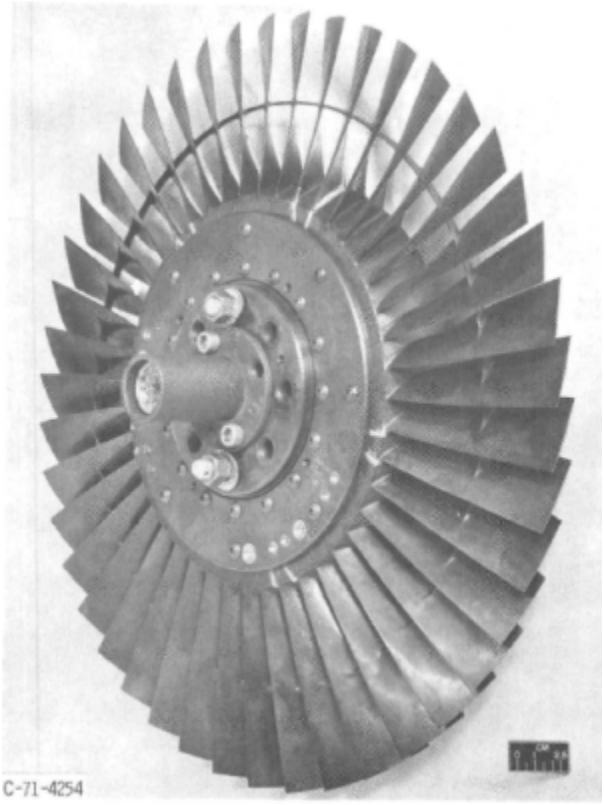


Fig1. https://ntrs.nasa.gov/citations/19740001915 p.62

Useful documents

- PDF of the NASA report : rotor11.pdf
- CSV file of the blade geometry : rotor11_original.csv

Geometry

The geometry of rotor 11 is described in the original NASA report by the following tables. The length are in centimeters and the angles in degrees.

TABLE IV. - BLADE GEOMETRY FOR ROTOR 11

RP	PERCENT SPAN	RADII RI	RADII RO	BLADE ANGLES KIC	BLADE ANGLES KTC	BLADE ANGLES KOC	DELTA INC	CONE ANGLE
TIP	0.	25.197	24.816	64.37	62.97	57.71	2.53	-10.431
1	5.	24.628	24.280	63.11	61.83	57.26	2.78	-9.182
2	10.	24.060	23.744	61.90	60.58	56.65	3.04	-8.035
3	30.	21.741	21.600	57.36	54.88	53.15	4.13	-3.095
4	45.	19.960	19.992	54.13	50.29	48.79	4.95	0.651
5	48.	19.658	19.724	53.59	49.49	47.87	5.09	1.291
6	50.	19.356	19.456	53.05	48.68	46.91	5.22	1.935
7	53.	19.052	19.188	52.51	47.86	45.89	5.36	2.581
8	55.	18.747	18.920	51.97	47.02	44.82	5.49	3.232
9	70.	16.871	17.313	48.65	42.07	36.74	6.30	7.403
10	90.	14.202	15.169	44.05	34.00	20.19	7.28	13.919
11	95.	13.492	14.633	42.82	31.93	14.48	7.49	15.774
HUB	100.	12.700	14.097	41.44	29.85	8.02	7.69	18.485

RP	BLADE THICKNESSES TI	BLADE THICKNESSES TM	BLADE THICKNESSES TO	AXIAL DIMENSIONS ZIC	AXIAL DIMENSIONS ZMC	AXIAL DIMENSIONS ZTC	AXIAL DIMENSIONS ZOC
TIP	0.051	0.152	0.051	1.046	2.039	2.444	3.116
1	0.051	0.162	0.051	1.002	2.040	2.415	3.156
2	0.051	0.172	0.051	0.955	2.040	2.381	3.198
3	0.051	0.215	0.051	0.761	2.027	2.191	3.363
4	0.051	0.248	0.051	0.621	2.021	2.003	3.502
5	0.051	0.254	0.051	0.598	2.019	1.967	3.527
6	0.051	0.260	0.051	0.574	2.018	1.930	3.553
7	0.051	0.265	0.051	0.550	2.017	1.892	3.579
8	0.051	0.271	0.051	0.526	2.016	1.852	3.606
9	0.051	0.306	0.051	0.377	2.003	1.588	3.774
10	0.051	0.356	0.051	0.147	1.989	1.143	4.050
11	0.051	0.370	0.051	0.079	1.983	1.013	4.116
HUB	0.051	0.385	0.051	0.000	1.972	0.861	4.179

Aerodynamic design

	unit	values
pressure ratio	[-]	1.57
mass flow	[kg/s]	29.5
tip speed	[m/s]	425
tip solidity	[-]	1.3
aspect ratio	[-]	2.5
number of blades	[-]	44
rotative speed	[rad/s]	1686

Material properties

The original material of the rotor 11 is not defined in the NASA report.

Considered properties: Ti-6Al-4V, generic titanium :

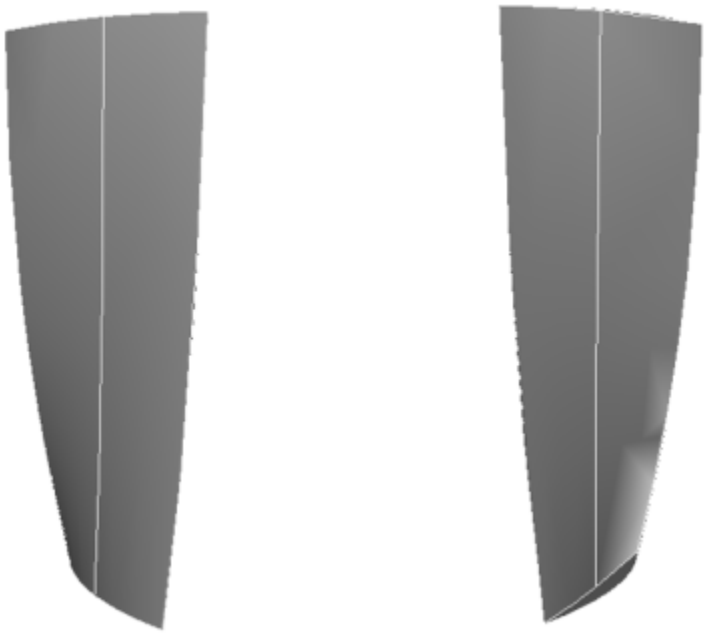
	unité	valeurs
alloy	[-]	Ti-6Al-4V
Young's modulus	[GPa]	108
density	[kg/m3]	4400
Poisson's ratio	[-]	0.34

	unité	valeurs
yield stress	[GPa]	0.824

First three natural frequencies (with clamped root) for the mesh:

1. (1B): 1349.9 rad/s / 214.8 Hz
2. (2B): 5271.3 rad/s / 838.9 Hz
3. (1T): 7863.9 rad/s / 1251.6 Hz

CAD



Fichiers téléchargeables
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Modèle original

Le rotor 11 fait partie d'un programme de recherche visant à étudier l'effet du débit massique par unité de surface annulaire sur les performances des soufflantes à flux axiaux. Une série de trois étages comprenant le rotor 11, 16 et 17 ont été conçus avec un débit massique par unité de surface annulaire de 198, 178 et 208 kilogrammes par seconde par mètre carré. Les trois étages ont été conçus pour produire un rapport de pression de 1.57.

* Rapport technique original [(cite:kovich1973design>Kovich. «Performance of transonic fan stage with weight flow per unit annulus area of 198 kilograms per sercond per square meter (40.6 (lb/sec)/ft²) »

1973. pdf)]:

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- Photographie :

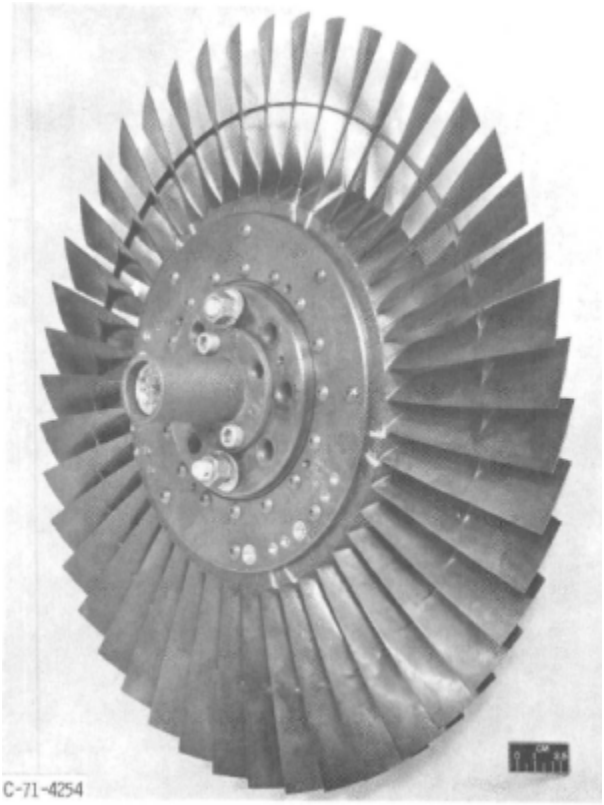


Fig1. https://ntrs.nasa.gov/citations/19740001915 p.62

Documents utiles

- PDF du rapport de la NASA : rotor11.pdf
- Fichier CSV de la géométrie : rotor11_original.csv

Géométrie

La géométrie du rotor 11 est décrite dans le rapport d'origine de la NASA par les tableaux suivants. Les grandeurs sont en centimètres et en degrés.

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HUB	0.051	0.385	0.051	0.000	1.972	0.861	4.179

Caractéristiques aérodynamiques

	unités	valeurs
taux de compression	[-]	1,57
débit massique	[kg/s]	29,5
vitesse en tête	[m/s]	425
solidité en tête	[-]	1,3
allongement	[-]	2,5
nombre d'aubes	[-]	44
vitesse de rotation	[rad/s]	1686

Propriétés matériau

Le matériau original du rotor 11 n'est pas défini dans le rapport de la NASA.

Propriétés considérées : alliage de titane Ti-6Al-4v :

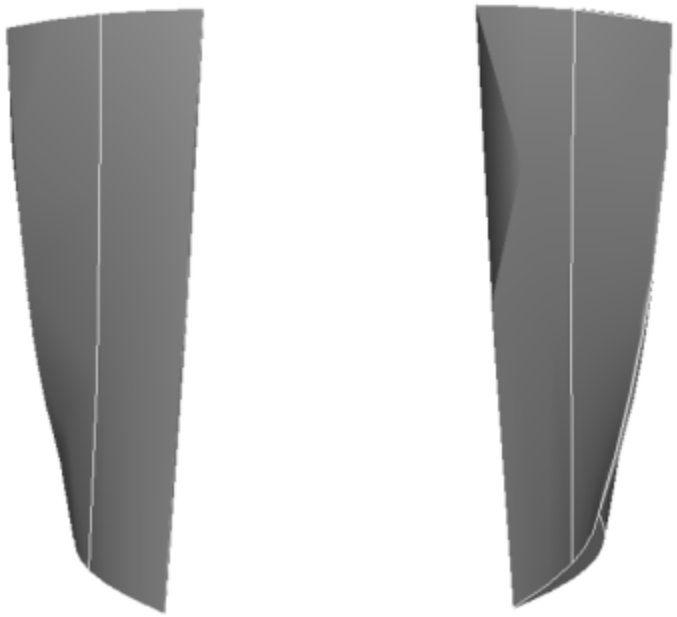
	unité	valeurs
alliage	[-]	Ti-6Al-4v
module d'Young	[GPa]	108
masse volumique	[kg/m3]	4400
coefficient de Poisson	[-]	0,34

	unité	valeurs
limite élastique	[GPa]	0,824

Fréquences des trois premiers modes (noeuds de la base encastrés) pour le maillage :

1. (1B): 1349,9 rad/s / 214,8 Hz
2. (2B): 5271,3 rad/s / 838,9 Hz
3. (1T): 7863,9 rad/s / 1251,6 Hz

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Document issu de la page wiki:
https://wiki.lava.polymtl.ca/public/modeles/rotor_11/accueil?rev=1663351953

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