Rotor 20

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Original model

Rotor 20 is part of a research program to study the effect of tip velocity ratio on compressors performances. It has been designed for a stage tip velocity ratio of 0.8.

- Original technical report [1]:

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@TechReport{moore1978design,
author      = {Moore, R. D. and Lewis, George W. and Osborn, Walter M.},
title       = {Performance of a Transonic Fan Stage Designed for a Low
Meridional Velocity Ratio},
institution = {NASA Lewis Research Center Cleveland, OH, United States},
note        = {NASA-TP-1298, url~:
\url{https://ntrs.nasa.gov/api/citations/19780025164/downloads/19780025164
.pdf}, 1978}}
```

- Picture :

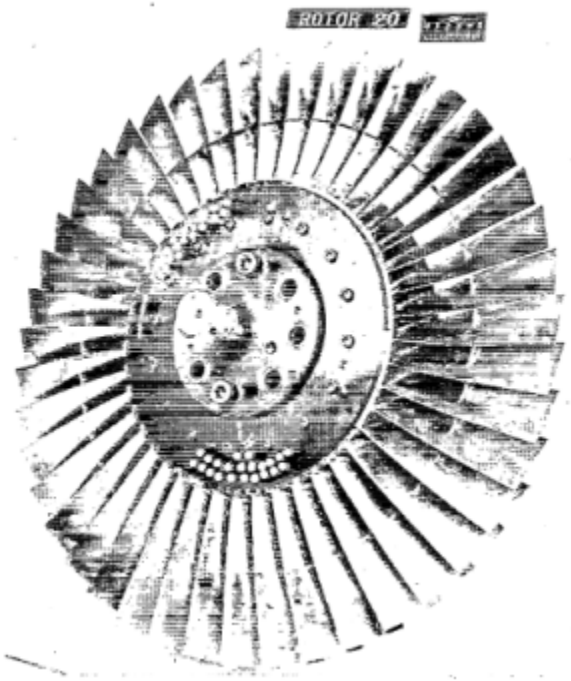


Fig1. https://ntrs.nasa.gov/api/citations/19780025164/downloads/19780025164.pdf p.61

Useful documents

- PDF of the NASA report : rotor20.pdf
- CSV file of the blade geometry : rotor20_original.csv

Geometry

The geometry of rotor 20 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 20

RP	PERCENT SPAN	RADII RI	RADII RO	BLADE ANGLES KIC	BLADE ANGLES KTC	BLADE ANGLES KOC	DELTA INC	CONE ANGLE
TIP	0.	25.281	25.171	63.94	63.97	59.17	2.52	-3.006
1	5.	24.724	24.614	62.90	62.83	58.74	2.77	-2.925
2	10.	24.156	24.057	61.85	61.62	58.16	3.03	-2.520
3	30.	21.810	21.629	57.80	56.14	55.16	4.11	0.434
4	50.	19.385	19.601	53.76	50.05	49.12	5.19	4.227
5	55.	18.764	19.044	52.71	48.42	48.96	5.46	5.281
6	58.	18.451	18.766	52.18	47.58	45.80	5.59	5.854
7	60.	18.136	18.487	51.64	46.73	44.57	5.73	6.399
8	63.	17.819	18.209	51.09	45.86	43.29	5.86	6.974
9	70.	16.851	17.373	49.43	43.22	38.64	6.26	8.822
10	90.	14.130	15.145	44.69	36.03	20.60	7.25	14.611
11	95.	13.408	14.588	43.40	34.05	14.33	7.46	16.271
HUB	100.	12.700	14.031	42.12	32.06	7.30	7.64	17.597

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	0.153	0.051	1.017	2.032	2.437	3.097
1	0.051	0.163	0.051	0.980	2.034	2.409	3.135
2	0.051	0.173	0.051	0.942	2.035	2.376	3.175
3	0.051	0.217	0.051	0.780	2.037	2.204	3.340
4	0.051	0.261	0.051	0.609	2.037	1.957	3.534
5	0.051	0.272	0.051	0.563	2.035	1.882	3.500
6	0.051	0.278	0.051	0.539	2.034	1.842	3.619
7	0.051	0.284	0.051	0.514	2.033	1.800	3.648
8	0.051	0.290	0.051	0.490	2.032	1.757	3.678
9	0.051	0.307	0.051	0.418	2.025	1.617	3.775
10	0.051	0.350	0.051	0.163	1.991	1.161	4.058
11	0.051	0.372	0.051	0.084	1.977	1.021	4.128
HUB	0.051	0.385	0.051	0.000	1.961	0.875	4.196

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 20 is not defined in the NASA report.

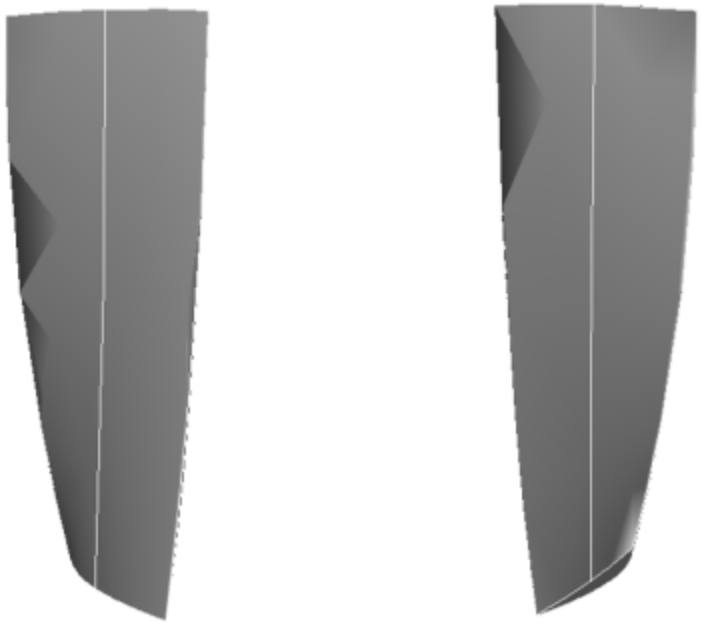
Considered properties: Ti-6Al-4V, generic titanium :

	unité	valeurs
alloy	[-]	Ti-6Al-4V
Young's modulus	[GPa]	108
density	[kg/m3]	4400
Poisson's ratio	[-]	0.34
yield stress	[GPa]	0.824

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

1. (1B): 1441.5 rad/s / 229.4 Hz
2. (2B): 5124.4 rad/s / 815.6 Hz
3. (1T): 8165.6 rad/s / 1299.6 Hz

CAD



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Libre accès

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Modèle original

Le rotor 20 fait partie d'un programme de recherche visant à étudier l'effet du rapport de vitesse en tête sur les performances des compresseurs. Il a été conçu pour un rapport de vitesse en tête de 0,8.

- Rapport technique original [1]:

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@TechReport{moore1978design,
author      = {Moore, R. D. and Lewis, George W. and Osborn, Walter M.},
title       = {Performance of a Transonic Fan Stage Designed for a Low
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.pdf}, 1978}}
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- Photographie :

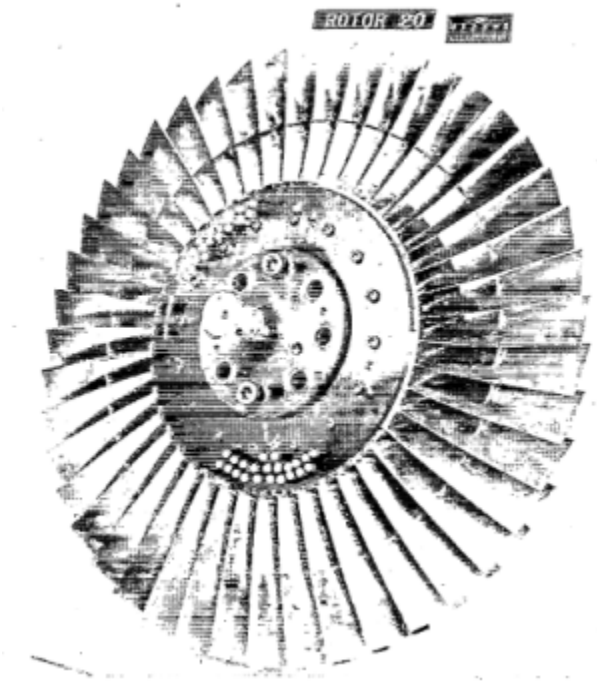

Fig1. https://ntrs.nasa.gov/api/citations/19780025164/downloads/19780025164.pdf p.61

Documents utiles

- PDF du rapport de la NASA : rotor20.pdf
- Fichier CSV de la géométrie : rotor20_original.csv

Géométrie

La géométrie du rotor 20 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	1.961	0.875	4.196

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 20 n'est pas défini dans le rapport de la NASA.

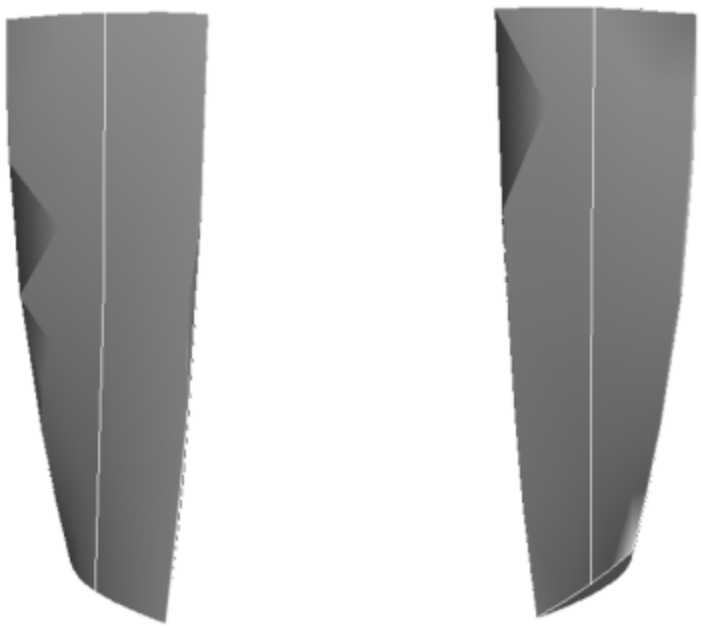
Propriétés considérées : alliage de titane Ti-6Al-4v :

	unité	valeurs
alliage	[-]	Ti-6Al-4v
module d'Young	[GPa]	108
masse volumique	[kg/m3]	4400
coefficient de Poisson	[-]	0,34
limite élastique	[GPa]	0,824

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

1. (1B): 1441,5 rad/s / 229,4 Hz
2. (2B): 5124,4 rad/s / 815,6 Hz
3. (1T): 8165,6 rad/s / 1299,6 Hz

CAO



1. [a, b] Moore. «Performance of a Transonic Fan Stage Designed for a Low Meridional Velocity Ratio » 1978. pdf