Rotor 74A2

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Original model

Compressor 74A is part of a research program to study fans and compressors for advanced airbreathing engines to assess and improve the technology needed for high pressure ratio, good efficiency, and adequate stall margin in as few stages as possible. This compressor consists of inlet guide vanes and five stages, and it is designed for a 9.271 pressure ratio. Rotor 74A2 is the rotor of the second stage of this compressor.

- Original technical report [(cite:steinke1986design>Steinke. «Design of 9.271-Pressure-Ratio Five-Stage Core Compressor and Overall Performance for First Three Stages » 1986. pdf)]:

```
@TechReport{steinke1986design,
author      = {Steinke, Ronald J.},
title       = {Design of 9.271-Pressure-Ratio Five-Stage Core Compressor
and Overall Performance for First Three Stages},
institution = {NASA Lewis Research Center Cleveland, OH, United States},
note        = {NASA-TP-2597, url~:
\url{https://ntrs.nasa.gov/citations/19870008266}, 1986}}
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Useful documents

- PDF of the NASA report : rotor74a2.pdf
- CSV file of the blade geometry : rotor74a2_original.csv

Geometry

The geometry of rotor 74A2 is described in the original NASA report by the following tables. The length are in centimeters and the angles in degrees.

(d) Rotor 2

RP	PERCENT SPAN	RADII RI	RD	BLADE ANGLES KIC	KTC	KOC	DELTA INC	CONE ANGLE
TIP	0.	24.778	24.300	63.49	54.90	46.37	3.35	-8.299
1	5.	24.307	23.868	61.92	53.79	45.88	3.64	-7.345
2	10.	23.867	23.504	60.51	52.77	45.40	3.92	-5.895
3	20.	23.025	22.800	58.15	50.89	44.17	4.46	-3.478
4	30.	22.201	22.110	56.40	49.13	42.43	4.97	-1.351
5	40.	21.390	21.433	54.91	47.30	40.06	5.47	.610
6	50.	20.581	20.765	53.48	45.47	37.09	5.96	2.505
7	60.	19.773	20.107	52.11	43.53	33.48	6.43	4.367
8	70.	18.966	19.462	50.81	41.51	29.22	6.88	6.218
9	80.	18.161	18.835	49.63	39.37	24.01	7.30	8.087
10	90.	17.355	18.230	48.67	36.98	16.95	7.64	9.992
11	95.	16.950	17.937	48.30	35.61	12.43	7.78	10.961
HUB	100.	16.487	17.556	47.87	34.05	6.70	7.94	11.527

RP	BLADE THICKNESSES TI	TM	TO	AXIAL DIMENSIONS ZI	ZMC	ZTC	ZO
TIP	.028	.201	.027	14.275	15.749	16.341	17.549
1	.030	.219	.030	14.201	15.745	16.279	17.603
2	.032	.236	.032	14.136	15.743	16.221	17.647
3	.037	.268	.038	14.029	15.741	16.103	17.729
4	.042	.300	.042	13.941	15.737	15.979	17.806
5	.046	.331	.047	13.859	15.732	15.849	17.888
6	.051	.362	.051	13.778	15.727	15.711	17.976
7	.055	.393	.056	13.697	15.721	15.564	18.070
8	.059	.425	.061	13.611	15.710	15.405	18.166
9	.064	.457	.065	13.520	15.698	15.237	18.270
10	.069	.490	.070	13.414	15.681	15.048	18.384
11	.071	.506	.072	13.349	15.665	14.941	18.443
HUB	.074	.525	.074	13.275	15.647	14.820	18.519

Aerodynamic design

	unit	values
pressure ratio	[-]	1.691
mass flow	[kg/s]	29.71
tip speed	[m/s]	416
tip solidity	[-]	1.25
aspect ratio	[-]	1.17
number of blades	[-]	32
rotative speed	[rad/s]	1680

Material properties

Rotor 74A2 is made of titanium according to the NASA report, but the exact properties are not provided.

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

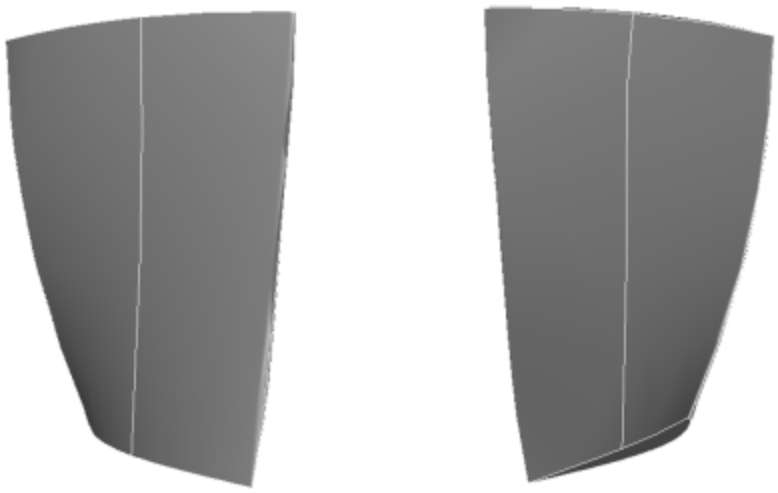
	unité	valeurs
alloy	[-]	Ti-6Al-4V
Young's modulus	[GPa]	108
density	[kg/m3]	4400
Poisson's ratio	[-]	0.34
yield stress	[GPa]	0.824

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

1. (1B): 4858.0 rad/s / 773.2 Hz

2. (1T): 15004.9 rad/s / 2388.1 Hz
3. (2B): 17105.4 rad/s / 2722.4 Hz

CAD



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Modèle original

Le compresseur 74A fait partie d'un programme de recherche visant à étudier les soufflantes et les compresseurs pour les moteurs avancés afin d'évaluer et d'améliorer la technologie nécessaire pour obtenir un rapport de pression élevé, un bon rendement et une marge de décrochage adéquate avec le moins d'étages possible. Ce compresseur est composé d'aubes directrices en entrée et de cinq étages, et il est conçu pour un rapport de pression de 9,271. Le rotor 74A2 est le rotor du deuxième étage de ce compresseur.

- Rapport technique original [(cite:steinke1986design>Steinke. «Design of 9.271-Pressure-Ratio Five-Stage Core Compressor and Overall Performance for First Three Stages » 1986. pdf)]:

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@TechReport{steinke1986design,
author      = {Steinke, Ronald J.},
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institution = {NASA Lewis Research Center Cleveland, OH, United States},
note        = {NASA-TP-2597, url~:
\url{https://ntrs.nasa.gov/citations/19870008266}, 1986}}
```

Documents utiles

- PDF du rapport de la NASA : rotor74a2.pdf
- Fichier CSV de la géométrie : rotor74a2_original.csv

Géométrie

La géométrie du rotor 74A2 est décrite dans le rapport d'origine de la NASA par les tableaux suivants. Les grandeurs sont en centimètres et en degrés.

(d) Rotor 2

	PERCENT	RADII		BLADE ANGLES			DELTA	CONE
RP	SPAN	RI	RO	KIC	KTC	KOC	INC	ANGLE
TIP	0.	24.778	24.300	63.49	54.90	46.37	3.35	-8.299
1	5.	24.307	23.868	61.92	53.79	45.88	3.64	-7.345
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HUB	100.	16.487	17.556	47.87	34.05	6.70	7.94	11.527

	BLADE THICKNESSES			AXIAL DIMENSIONS			
RP	TI	TM	TO	ZI	ZMC	ZTC	ZO
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1	.030	.219	.030	14.201	15.745	16.279	17.603
2	.032	.236	.032	14.136	15.743	16.221	17.647
3	.037	.268	.038	14.029	15.741	16.103	17.729
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5	.046	.331	.047	13.859	15.732	15.849	17.888
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11	.071	.506	.072	13.349	15.665	14.941	18.443
HUB	.074	.525	.074	13.275	15.647	14.820	18.519

Caractéristiques aérodynamiques

	unités	valeurs
taux de compression	[-]	1,691
débit massique	[kg/s]	29,71
vitesse en tête	[m/s]	416
solidité en tête	[-]	1,25
allongement	[-]	1,17
nombre d'aubes	[-]	32
vitesse de rotation	[rad/s]	1680

Propriétés matériau

Le matériau du rotor 74A2 est le titane d'après le rapport, mais ses caractéristiques ne sont pas fournies.

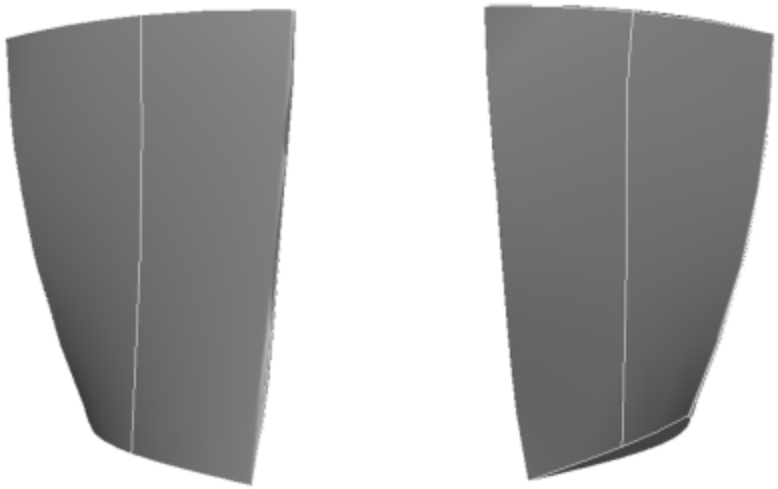
Propriétés considérées : allaige Ti-6Al-4V

	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): 4858,0 rad/s / 773,2 Hz
2. (1T): 15004,9 rad/s / 2388,1 Hz
3. (2B): 17105,4 rad/s / 2722,4 Hz

CAO



Document issu de la page wiki:
https://wiki.lava.polymtl.ca/public/modeles/rotor_74a2/accueil?rev=1668794573

Dernière mise à jour: **2023/04/05 08:59**