

Rotor 18

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Original model

One way to reduce compressor weight is to obtain a high pressure ratio per stage, thereby reducing the number of stages. As a consequence, several single-stage fans have been designed to produce stage pressure ratios ranging from 1.9 to 2.2. Rotor 18 is one of those fans with a pressure ratio of 1.925.

- Original technical report ^[1]:

```
@TechReport{lewis1974design,  
author      = {Lewis, George W. and Reid, Lonnie and Tysl, Edward R.},  
title       = {Design and performance of a high-pressure-ratio, highly  
loaded axial-flow transonic compressor stage},  
institution = {NASA Lewis Research Center Cleveland, OH, United States},  
note        = {NASA-TM X-3100, url~:  
  \url{https://ntrs.nasa.gov/citations/19740025108}, 1974}}
```

- Picture :



Fig1. <https://catalog.archives.gov/id/17422714>

```
@Misc{huebler1974records,  
author  = {Huebler, D.},  
title   = {Rotor 18. {R}ecords of the {N}ational {A}eronautics and {S}pace  
{A}dministration, 1903 - 2006. {P}hotographs relating to agency activities,  
facilities and personnel, 1973 - 2013},  
note    =  
{\href{https://catalog.archives.gov/id/17422714}{https://catalog.archives.gov/  
id/17422714}, 1974 }, % for Fig. 1}
```

Useful documents

- PDF of the NASA report :

rotor18.pdf

- CSV file of the blade geometry :

rotor18_original.csv

Geometry

The geometry of rotor 18 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 18

RP	PERCENT		RADI		BLADE ANGLES			DELTA	CONE
	SPAN	R1	R0		KIC	KTC	KOC	[NC	ANGLE
TIP	0.	25.019	24.359		63.50	60.06	48.60	2.49	-15.536
1	5.	24.442	23.871		61.91	58.53	47.71	2.75	-12.940
2	10.	23.906	23.383		60.51	57.10	46.55	3.00	-11.383
3	30.	21.655	21.433		55.62	51.09	39.82	4.08	-4.201
4	48.	19.590	19.726		52.08	45.52	31.18	5.03	2.263
5	50.	19.288	19.482		51.61	44.86	29.62	5.17	3.196
6	53.	18.983	19.238		51.14	44.24	27.97	5.30	4.131
7	55.	18.676	18.994		50.68	43.63	26.26	5.43	5.076
8	58.	18.367	18.750		50.22	42.97	24.48	5.56	6.033
9	70.	16.777	17.531		48.02	39.76	14.38	6.16	10.944
10	90.	14.079	15.580		44.63	35.58	-7.70	6.86	19.179
11	95.	13.384	15.093		43.76	34.81	-14.81	6.97	21.167
HUB	100.	12.700	14.605		42.89	34.15	-22.54	7.04	22.937

RP	BLADE THICKNESSES			AXIAL DIMENSIONS			
	T1	TM	TO	ZIC	ZMC	ZTC	ZOC
TIP	0.051	0.152	0.051	1.148	2.212	2.267	3.523
1	0.051	0.163	0.051	1.087	2.213	2.225	3.573
2	0.051	0.173	0.051	1.031	2.213	2.183	3.626
3	0.051	0.216	0.051	0.812	2.205	1.966	3.847
4	0.051	0.256	0.051	0.627	2.193	1.719	4.048
5	0.051	0.262	0.051	0.602	2.191	1.681	4.076
6	0.051	0.267	0.051	0.578	2.188	1.643	4.125
7	0.051	0.273	0.051	0.554	2.185	1.604	4.133
8	0.051	0.279	0.051	0.529	2.182	1.563	4.160
9	0.051	0.309	0.051	0.396	2.164	1.341	4.296
10	0.051	0.360	0.051	0.149	2.126	0.924	4.466
11	0.051	0.373	0.051	0.076	2.117	0.807	4.488
HUB	0.051	0.386	0.051	0.000	2.107	0.687	4.502

Aerodynamic design

	unit	values
pressure ratio	[-]	1.925
mass flow	[kg/s]	29.5
tip speed	[m/s]	422
tip solidity	[-]	1.7
aspect ratio	[-]	2.6
number of blades	[-]	56
rotative speed	[rad/s]	1686

Material properties

The original material of the rotor 18 is not defined in the NASA report.

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

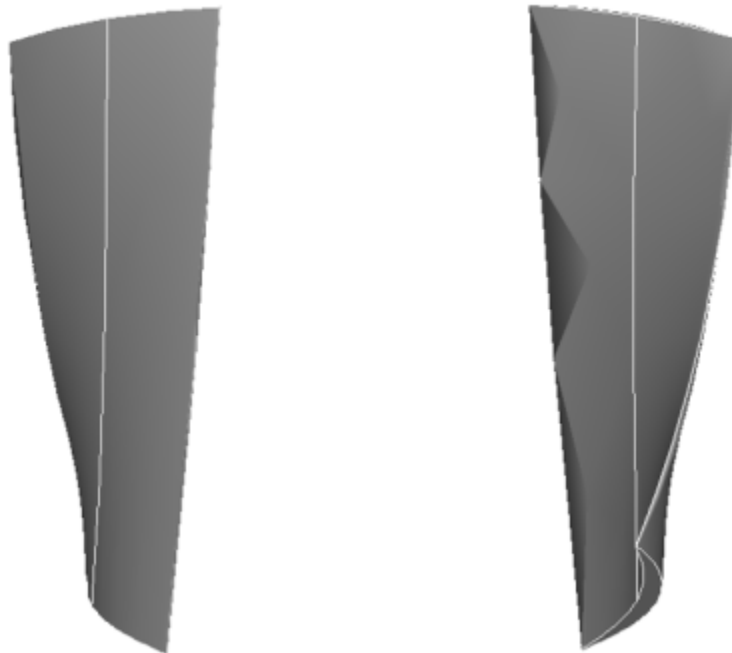
	unité	valeurs
alloy	[-]	Ti-6Al-4V
Young's modulus	[GPa]	108
density	[kg/m3]	4400
Poisson's ratio	[-]	0.34

	unité	valeurs
yield stress	[GPa]	0.824

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

1. (1B): 2040.6 rad/s / 324.8 Hz
2. (2B): 6744.2 rad/s / 1073.4 Hz
3. (1T): 10769.2 rad/s / 1714.0 Hz

CAD



Fichiers téléchargeables

x

Libre accès

[lien vers le projet Git](#)

Modèle original

Une façon de réduire le poids d'un compresseur est d'atteindre un rapport de pression élevé par étage, ce qui permet de réduire le nombre d'étages de ce compresseur. Par conséquent, plusieurs soufflantes à un étage ont été conçus pour produire des rapports de pression par étage allant de 1,9 à 2,2. Le rotor 18 est donc une de ces soufflantes et possède un taux de compression de 1,925.

- Rapport technique original ^[1]:

@TechReport{lewis1974design,

```
author      = {Lewis, George W. and Reid, Lonnie and Tysl, Edward R.},
title       = {Design and performance of a high-pressure-ratio, highly
loaded axial-flow transonic compressor stage},
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- Photographie :



Fig1. <https://catalog.archives.gov/id/17422714>

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id/17422714}, 1974 }, % for Fig. 1}
```

Documents utiles

- PDF du rapport de la NASA :
- Fichier CSV de la géométrie :

rotor18.pdf

rotor18_original.csv

Géométrie

La géométrie du rotor 18 est décrite dans le [rapport d'origine de la NASA](#) par les tableaux suivants. Les grandeurs sont en centimètres et en degrés.

TABLE IV. - BLADE GEOMETRY FOR ROTOR 18

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2	0.051	0.173	0.051	1.031	2.213	2.183	3.626
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11	0.051	0.373	0.051	0.076	2.117	0.807	4.488
HUB	0.051	0.386	0.051	0.000	2.107	0.687	4.502

Caractéristiques aérodynamiques

	unités	valeurs
taux de compression	[-]	1,925
débit massique	[kg/s]	29,5
vitesse en tête	[m/s]	422
solidité en tête	[-]	1,7
allongement	[-]	2,6
nombre d'aubes	[-]	56
vitesse de rotation	[rad/s]	1686

Propriétés matériau

Le matériau original du rotor 18 n'est pas défini dans le rapport de la NASA.

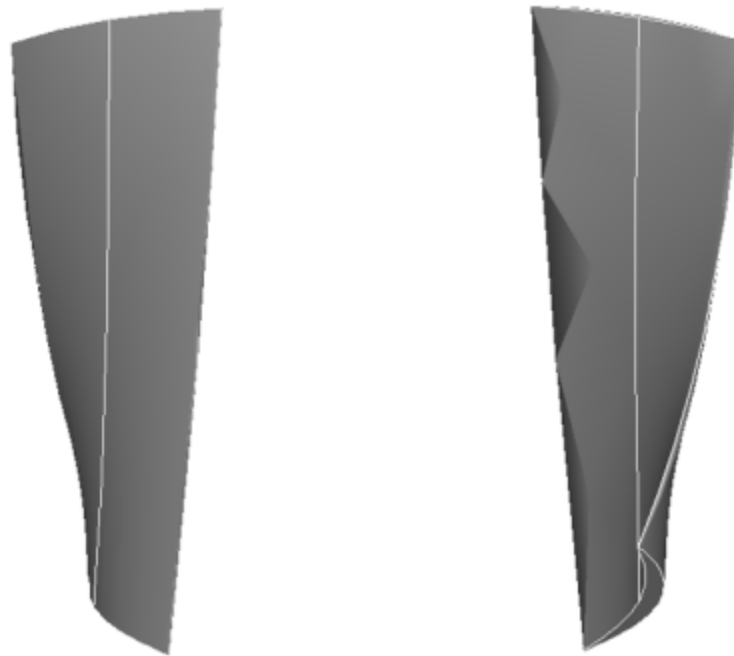
Propriétés considérées : alliage de titane Ti-6Al-4v :

	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): 2040,6 rad/s / 324,8 Hz
2. (2B): 6744,2 rad/s / 1073,4 Hz
3. (1T): 10769,2 rad/s / 1714,0 Hz

CAO



1. ^{a, b} Lewis. «Design and performance of a high-pressure-ratio, highly loaded axial-flow transonic compressor stage » 1974. [pdf](#)

Document issu de la page wiki:

https://lava-wiki.meca.polymtl.ca/public/modeles/rotor_18/accueil?rev=1663351842

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