Rotor 2

- Français
- English

About

Rotor 2 is part of a research program to study aspect ratio because the use of high aspect ratio blading can lead to a decrease in the axial length of compressors and therefore a reduction of their size and weight. To investigate the effects of aspect ratio on compressor range and efficiency, two transonic rotors (rotor 1 and 2) were designed and tested. The variation in aspect ratio was based on a change in aerodynamic chord, and the solidity was kept the same by varying the number of blades.

- Original technical report [(cite:reid1974design>Reid. «Performance of a transonic compressor rotor with an aspect ratio of 6.5 » 1974. pdf)]:

```
@TechReport{reid1974design,
  author           = {Reid, L. and Tysl, Edward R.},
  date             = {1974},
  institution      = {NASA Lewis Research Center Cleveland, OH, United
States},
  title            = {Performance of a transonic compressor rotor with an
aspect ratio of 6.5},
  number           = {NASA-TN D-7662},
  url              = {https://ntrs.nasa.gov/citations/19740018136},
  }
```

- Picture :

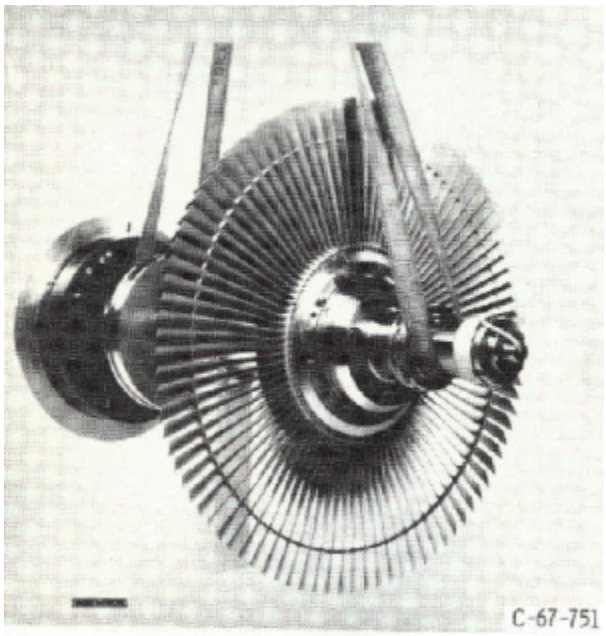


Fig1. https://ntrs.nasa.gov/citations/19740018136 p.61

Useful documents

- NASA technical report (.pdf)
- geometrical parameters file (.csv), usable as input of OpenMCAD[(cite:Kojtych_2022_gene_aubes>Kojtych S., Batailly A. «OpenMCAD, an open blade generator: from Multiple-Circular-Arc profiles to Computer-Aided Design model» 2022. code en libre accès)] to generate reference blade models.

Reference blade

The **reference blade** is defined with multiple-circular arc profiles[(cite:Crouse_1969_computer)] given in the original NASA report[(cite:hager1974design)]. Corresponding models are computed with the open-source code OpenMCAD[(cite:Kojtych_2022_gene_aubes)].

Geometry

The geometry of rotor 2 is described in the original NASA report by the following tables. The length are in inches and the angles in degrees.

TABLE III. - BLADE GEOMETRY FOR ROTOR 2

RP	PERCENT SPAN	RADII RI	RO	BLADE ANGLES KIC	KTC	KOC	DELTA INC
TIP	0.	10.000	9.900	60.31	55.15	50.05	2.07
1	5.	9.734	9.647	58.77	54.04	49.32	2.10
2	10.	9.451	9.395	57.23	52.71	48.19	2.15
3	20.	8.880	8.889	54.39	49.55	44.70	2.30
4	30.	8.308	8.384	51.87	45.75	39.65	2.50
5	33.	8.168	8.258	51.28	44.73	38.20	2.54
6	35.	8.030	8.131	50.71	43.68	36.67	2.59
7	38.	7.892	8.005	50.15	42.60	35.06	2.63
8	40.	7.755	7.879	49.61	41.49	33.36	2.67
9	50.	7.193	7.373	47.16	36.38	25.59	3.00
10	60.	6.622	6.868	44.49	30.45	16.41	3.50
11	90.	4.708	5.352	35.36	10.55	-14.26	7.27
HUB	100.	4.000	4.847	32.21	4.44	-23.34	10.23

RP	BLADE THICKNESSES TI	TM	TO	AXIAL DIMENSIONS ZMC	ZTC	ZOC	CONE ANGLE
TIP	0.020	0.037	0.020	0.248	0.248	0.530	-6.411
1	0.020	0.037	0.020	0.257	0.257	0.545	-5.531
2	0.020	0.038	0.020	0.266	0.266	0.562	-3.612
3	0.020	0.039	0.020	0.286	0.286	0.602	0.599
4	0.020	0.041	0.020	0.306	0.306	0.647	4.884
5	0.020	0.041	0.020	0.310	0.310	0.658	5.733
6	0.020	0.041	0.020	0.315	0.315	0.668	6.522
7	0.020	0.042	0.020	0.319	0.319	0.679	7.252
8	0.020	0.042	0.020	0.323	0.323	0.690	7.923
9	0.020	0.045	0.020	0.344	0.344	0.739	11.459
10	0.020	0.049	0.020	0.366	0.366	0.789	15.435
11	0.020	0.083	0.020	0.402	0.402	0.838	35.893
HUB	0.020	0.111	0.020	0.392	0.392	0.799	43.582

Aerodynamic design

	unit	value
pressure ratio	[-]	1.53
mass flow	[kg/s]	30.7
tip speed	[m/s]	350.8
tip solidity	[-]	1.3
aspect ratio	[-]	6.5
rotative speed	[rad/s]	1381.25

Material properties

The material of rotor 2 is not defined in the original NASA report. A 200-grade maraging steel is considered:

	unit	value
alloy	[-]	18-Ni-200-maraging
Young's modulus	[GPa]	180
density	[kg/m3]	8000
Poisson's ratio	[-]	0.3
yield stress	[GPa]	1.38

CAD

CAD model

The CAD model is computed with the open source code OpenMCAD[(cite:Kojtych_2022_gene_aubes)].



pressure side



suction side

Natural frequencies

First three natural frequencies (with clamped root) for the mesh computed with OpenMCAD[(cite:Kojtych_2022_gene_aubes)]:

> Currently not available because of a problem to compute them with aster from the mesh of the reference blade.

À propos

Le rotor 2 fait partie d'un programme de recherche visant à étudier l'allongement des aubes, car l'utilisation d'un fort allongement peut conduire à une diminution de la longueur axiale des compresseurs et donc à une réduction de leur taille et poids. Pour étudier les effets de cet allongement sur les rendements des compresseurs, deux rotors transsoniques (rotor 1 et 2) ont été conçus et testés. La variation d'allongement entre ces deux rotors a été effectuée grâce à une modification de la corde aérodynamique et la solidité a été maintenue identique en faisant varier le nombre d'aubes.

- Rapport technique original [(cite:reid1974design>Reid. «Performance of a transonic compressor rotor with an aspect ratio of 6.5 » 1974. pdf)]:

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- Photographie :

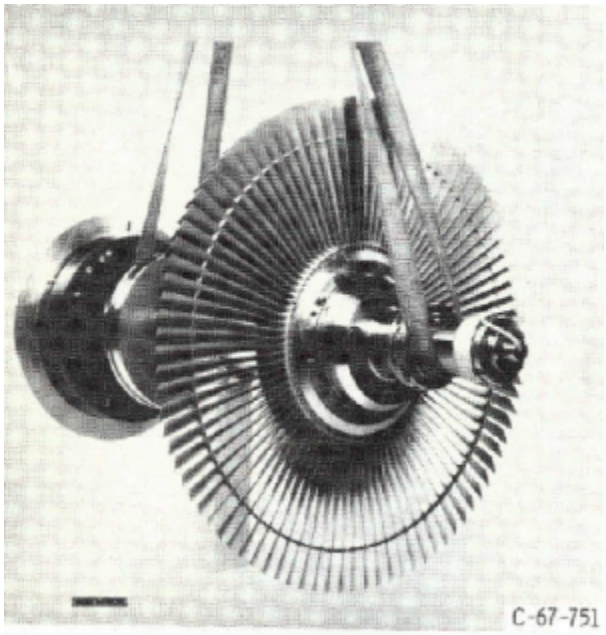


Fig1. https://ntrs.nasa.gov/citations/19740018136 p.61

Documents utiles

- rapport technique original

de la NASA (.pdf)
- fichier de paramètres géométriques (.csv), utilisable en entrée de OpenMCAD[(cite:Kojtych_2022_gene_aubes>Kojtych S., Batailly A. «OpenMCAD, an open blade generator: from Multiple-Circular-Arc profiles to Computer-Aided Design model» 2022. code en libre accès)] pour générer l'aube de référence

Aube de référence

L'**aube de référence** est définie par des profils de type arcs circulaires multiples[(cite:Crouse_1969_computer>Crouse *et al*. «A computer program for composing compressor blading from simulated circular-arc elements on conical surfaces » 1969. NASA-TN-D-5437. pdf)], donnés dans le rapport technique original de la NASA[(cite:hager1974design)]. Les modèles associés sont obtenus avec le code en libre accès OpenMCAD[(cite:Kojtych_2022_gene_aubes)].

Géométrie

La géométrie du rotor 2 est décrite dans le rapport d'origine de la NASA par les tableaux suivants. Les grandeurs sont en pouces et en degrés.

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11	0.020	0.083	0.020	0.402	0.402	0.838	35.893
HUB	0.020	0.111	0.020	0.392	0.392	0.799	43.582

Caractéristiques aérodynamiques

	unités	valeurs
taux de compression	[-]	1,53
débit massique	[kg/s]	30,7
vitesse en tête	[m/s]	350,8
solidité en tête	[-]	1,3
allongement	[-]	6.5
vitesse de rotation	[rad/s]	1381,25

Propriétés matériau

Le matériau original du rotor 1 n'est pas défini dans le rapport de la NASA. Un acier maraging de grade 200 est considéré:

	unité	valeurs
alliage	[-]	18-Ni-200-maraging
module d'Young	[GPa]	180
masse volumique	[kg/m3]	8000
coefficient de Poisson	[-]	0,3
limite élastique	[GPa]	1,38

Modèle CAO



intrados



extrados

Fréquences propres

Fréquences des trois premiers modes (noeuds du pied d'aube encastrés) pour le maillage obtenu avec OpenMCAD[(cite:Kojtych_2022_gene_aubes)] :

> Il y a actuellement un problème sur le calcul des fréquences propres dans Aster.

</tabs>

Document issu de la page wiki:
https://wiki.lava.polymtl.ca/public/modeles/rotor_02/accueil?rev=1677698965

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