

Rotor 2

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Original model

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 ^[1]:

```
@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 :

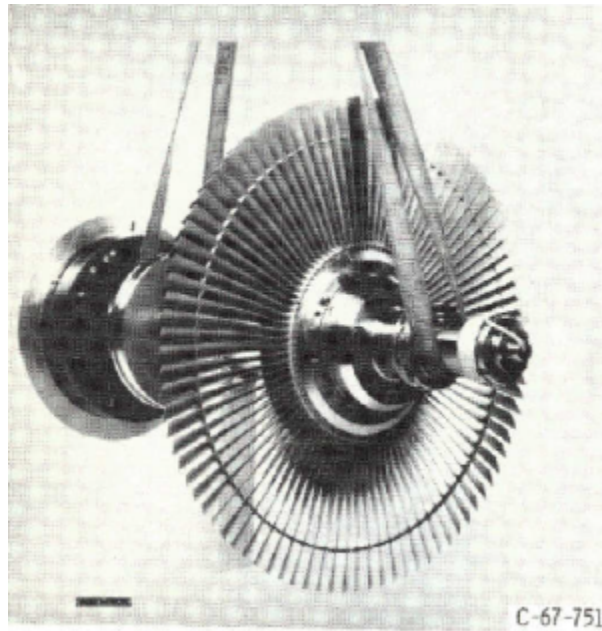


Fig1. <https://ntrs.nasa.gov/citations/19740018136> p.61

Useful documents

- PDF of the NASA report :

rotor2.pdf

- CSV file of the blade geometry :

rotor2_original.csv

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 | | RADIO | | BLADE ANGLES | | | DELTA INC |
|-----|---------|--------|-------|-------|--------------|--------|-------|--------------|
| | SPAN | RI | RO | KIC | KTC | KOC | | |
| 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 | | | AXIAL DIMENSIONS | | | CONE ANGLE |
|-----|-------------------|-------|-------|------------------|-------|-------|---------------|
| | TI | TM | TO | ZMC | ZTC | ZOC | |
| 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 | values |
|----------------|---------|---------|
| 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

Rotor 2 is made of a 200-grade maraging steel

| | unité | valeurs |
|-----------------|----------------------|--------------------|
| alloy | [-] | 18-Ni-200-maraging |
| Young's modulus | [GPa] | 180 |
| density | [kg/m ³] | 8000 |
| Poisson's ratio | [-] | 0.3 |
| yield stress | [GPa] | 1.38 |

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

1. (1B): 1686.8 rad/s / 268.5 Hz
2. (2B): 6385.2 rad/s / 1016.2 Hz
3. (1T): 8140.1 rad/s / 1295.5 Hz

CAD



Fichiers téléchargeables

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Libre accès

[lien vers le projet Git](#)

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 ^[1]:

```
@TechReport{reid1974design,  
  author      = {Reid, L. and Tysl, Edward R.},  
  date        = {1974},  
  institution = {NASA Lewis Research Center Cleveland, OH, United  
States},
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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},
}
```

- Photographie :

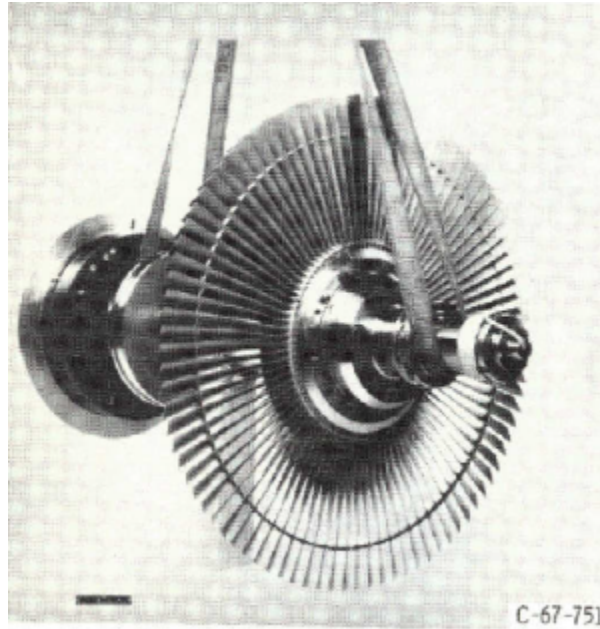


Fig1. <https://ntrs.nasa.gov/citations/19740018136> p.61

Documents utiles

- rapport technique original de la NASA (.pdf)
- [fichier de paramètres géométriques](#) (.csv), utilisable en entrée de OpenMCAD^[2] pour générer l'aube de référence

Aube de référence

L'**aube de référence** est définie par des profils de type arcs circulaires multiples^[3], donnés dans le rapport technique original de la NASA^[4]. Les modèles associés sont obtenus avec le code en libre accès OpenMCAD^[2].

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.

TABLE III. - BLADE GEOMETRY FOR ROTOR 2

| RP | PERCENT | | RADI | | BLADE ANGLES | | | DELTA INC |
|-----|---------|--------|-------|-------|--------------|--------|-------|--------------|
| | SPAN | R1 | RO | K1C | K7C | KOC | | |
| 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 | 35. | 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 | | | AXIAL DIMENSIONS | | | CONE ANGLE |
|-----|-------------------|-------|-------|------------------|-------|-------|---------------|
| | T1 | TM | TO | ZMC | Z7C | ZOC | |
| 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 |

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:

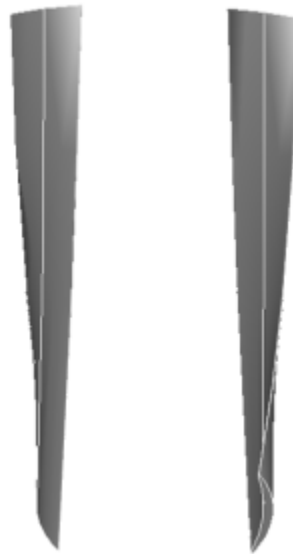
| | unité | valeurs |
|------------------------|---------|--------------------|
| alliage | [-] | 18-Ni-200-maraging |
| module d'Young | [GPa] | 180 |
| masse volumique | [kg/m3] | 8000 |
| coefficient de Poisson | [-] | 0,3 |

| | unité | valeurs |
|-------------------------|-------|---------|
| limite élastique | [GPa] | 1,38 |

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

1. (1B): 1686,8 rad/s / 268,5 Hz
2. (2B): 6385,2 rad/s / 1016,2 Hz
3. (1T): 8140,1 rad/s / 1295,5 Hz

CAO



</tabs>

1. ^{a, b} Reid. «Performance of a transonic compressor rotor with an aspect ratio of 6.5 » 1974. [pdf](#)
2. ^{a, b} Kojtych S., Batailly A. «OpenMCAD, an open blade generator: from Multiple-Circular-Arc profiles to Computer-Aided Design model» 2022. [code en libre accès](#)
3. ^a Crouse *et al.* «A computer program for composing compressor blading from simulated circular-arc elements on conical surfaces » 1969. NASA-TN-D-5437. [pdf](#)

Document issu de la page wiki:

https://lava-wiki.meca.polymtl.ca/public/modeles/rotor_02/accueil?rev=1677698326

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