IJARSCT

ISSN (Online) 2581-9429

International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

IJARSCT

Impact Factor: 6.252

Volume 3, Issue 1, January 2023

Parametric Analysis of a Screw Compressor :- A Critical Review

Dhrumilkumar Valand[1], Dr. K. K. Bhabhor[2], Dr. D. B. Jani[3], Mr. Timir Gandhi[4]

Student, Department of Mechanical Engineering (CAD\CAM)1

Department of Mechanical Engineering[2,3,4]

Government Engineering College, Dahod, Gujrat, India

[1]dvaland91278@gmail.com,[2]kiranmech12@gmail.com

[3]dbjani@rediffmail.com,[4]tpgautodept@gmail.com

Abstract: *Rotary twin screw compressor are widely used in the refrigeration, gas processing and energy industries and their application are diverse. Flow rate, pressure, temperature and working fluid are all factors to consider for good screw compressor. Twin-screw compressor are generally simple and small in construction with improved dependability, due to a lower moving components. They are primarily classed as oil-free and oil-flooded, and owing to their low cost, they may be used to compress helium and other gases in addition to air. Twin screw compressor are replacing reciprocating compressor due to improved profile design. Because of technological advancements and continues improvement the industry's necessity for exact performance projections has become a reality advances in the current analytical and simulation tools where appropriately can be proven by experimental investigation.*

Keywords: Computational fluid dynamics (CFD), screw compressor, leakages, rotor profile.

Nomenclatures

Computational fluid dynamics (CFD)

Vapour injection (VI)

Kinetic energy- epsilon ($K-\varepsilon$) turbulence

Pressure volume (P-V) indicator diagram

M^3/h. - meter^3/ hour

M^3/min - meter^3 / minute

Revolution per minute (RPM)

Kg/s - kilogram/secondFinite element analysis (FEA)

I. INTRODUCTION

A rotary -screw compressor is a one of the of gas compressor that utilises a rotary-type positive-displacement mechanism. When larger volumes of compressed gas are required, such as for large refrigeration cycles like chillers or for compressed air systems to operate air-driven tools like jackhammers and impact wrenches, these compressors, which are frequently used in industrial applications, take the place of more traditional piston compressors. The inherent leakage in the rotors increases significantly for lower rotor diameters, making this sort of mechanism less appropriate for smaller compressors than piston compressors. The only difference between the screw compressor and the screw pump is that the pockets of trapped material grow smaller as they go up the screw, compressing the material inside. As a result, a screw pump's screw is symmetrical all the way around, whereas a screw compressor's screw is asymmetrical throughout its length. There is relatively minimal pulsation or surge in the flow of gas when using a rotary screw compressor compared to piston compressors since the process of compressing gas is a continuous sweeping action. Additionally, even at enormous capacities, this enables screw compressors to be substantially quieter and vibrate far less than piston compressors, which has some positive effects on efficiency. It used to increase the pressure of a gas or vapour by reducing its volume (as in positive displacement machines) or by imparting high kinetic energy to it, which is transformed into pressure in a diffuser (as in the case of centrifugal machines). Screw compressors' (Fig.1) dependability is thus at least as critical as their efficiency. Significant progress has been achieved in the design and construction of the primary components of these machines, such as the rotors and bearings, in recent years. As a result, formerly unthinkable increases in performance and reliability have occurred. Screw compressor components may now be manufactured with great accuracy because to the rapid development of manufacturing technology over the last several decades. Screw compressor rotors may currently be manufactured at a low cost with tolerance of 5 µm. Casing bores may be produced with a reproducibility of 2 µm (Kovacevic et al., n.d.2002)[1]. This enabled the production of screw compressors with minimal level clearances. The rotors with changing profile and non-parallel axes have recently been designed for compressor applications (Dmitriev & Arbon, 2017)[2]. This design poses difficulties in attaining high precision in rotor manufacturing utilising efficient and cost-effective technologies. The author has also investigated a simpler arrangement with constant pitch and profile rotors with fixed ports (Read et al., 2017)[3]. CFD allows for the visualisation of oil flow within the compression chamber, however this has yet to be proven by test data. Some CFD-based research on oil distribution in simple bearing chambers and rotary compressors have demonstrated how to increase cooling and lubrication performance (Wu et al, 2017)[4]. Screw compressors were excluded due to their more complicated rotor shape.

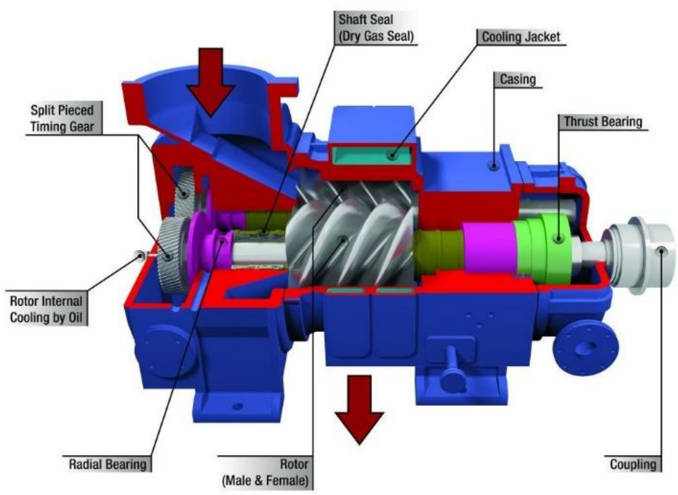

Figure-1 Parts of screw compressor

Consideration of different factors for Twine Screw Compressor

A number of design factors influence twin-screw compressor performance, which can be broadly categories as for geometric factors, such as rotor profile, number of rotor lobes, rotor length to diameter ratio (L/D) ratios, wrap angle, clearances, oil injection port location, discharge port size, built-in volume ratio, and so on; and operating factors, such as oil injection flow and temperature, tip speed, gas and oil. It is critical to understand the various impact on the compressor's performance when selecting a twin-screw compressor for a certain application (Rane,s., kovacevic, a & stosic, n.2016)[5].

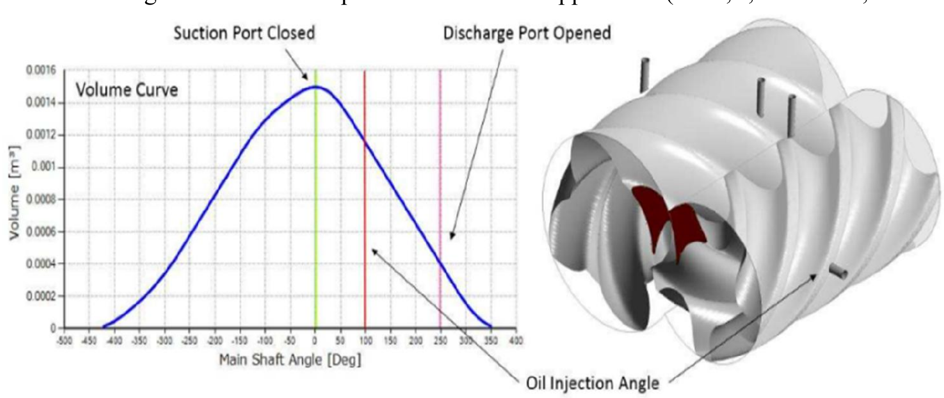

Figure-2 Oil injected ports and injection angle on a compression volume curve

Studies of Pressure and volume for twine screw compressor

Analysis of the working process in an oil-flooded screw compressor (Fig-2) by means of an indicator diagram Utilized small pressure transducers inserted into the grooves of the female rotor to transfer the pressure signal to the data collection system in order to record and analyse indicator diagrams of a refrigeration twin-screw compressor under varied operating situations (Peng et al., 2002)[6]. The research was furthered to examine the effects of variables on the thermodynamic operation of oil-flooded twin-screw compressors, such as pressure ratio, rotation speed, and oil-gas ratio. The research took into consideration the pressure differences during discharge and recommended advance discharge and modifying the discharge port to prevent over-compression.

The mathematical representation of the operation of screw compressors, in which the three types of fluids inlet fluid, primitive volume fluid, and exit fluid are partitioned among the internal flow domains (Xueming et al., n.d. 2014)[7]. To represent the dynamic properties of the flow domains in a screw compressor, the suction, compression, and discharge processes were simulated using the grid interface method and dynamic mesh methodology of computational fluid dynamics (CFD) theory. Experiments on the pressure-volume changes in screw compressor were conducted to confirm that the model is numerically accurate and that the simulation method is effective.

The computational fluid dynamics (CFD) technology simulates the operation of a twin-screw compressor with vapour injection (VI) (H. Wu et al., 2020)[8]. The geometries of the gas-liquid interface and the computation of the turbulent flow fields in the twin-screw compressor have been determined using a homogeneous multiphase flow model in conjunction with the volume-of-fluid (VOF) approach for interface capture. Analysis is done on how the VI pressure and VI location affect the twin-screw compressor's performance. The findings of the CFD simulation are compatible with the experimental data when the P-indicator diagram and the compressor's performance parameters are compared to the experimental data. The power of the compressor will progressively increase as the VI pressure rises at the same VI setting, and the efficiency of Compressor will rise first, followed by a dip, simulating the operation of a twin-screw compressor with VI. As a result, the best VI pressure may be identified in order to maximise compressor efficiency. There is also a perfect VI setting to increase the compressor's effectiveness under the same VI pressure.

Sr. no	Name of the investigator	Focus of the research work	Key findings/ results
1	Xueyuan Peng	experimental investigation of the thermodynamic processes in an oil-flooded screw compressor	The volume was constant at the start of discharge because of the gas back flow and pressure increased at the end. The over-compression observed during the operation
2	He Xueming	$k-\varepsilon$ turbulence model use and experimental – numerical data analysed	The same screw compressor dynamic simulation data agrees well with the experimental data, which proves the correctness and effectiveness of the dynamic simulation method
3	Huagen Wu	Analyse the vapour injection pressure and optimum pressure	The compressor with VI has a higher pressure almost during the whole compression process than without VI, because the refrigerant is injected into the compressor. With the increase of VI pressure, the input power, the shaft power and the indicated power are rising. Under the same VI pressure, with the increase of built-in volume ratio for the VI port position, the refrigerant gas injected into the compressor through the VI port decreases, and the power of the compressor decreases. However, the efficiency of the compressor increases first and then decreases.

Table-1: Summary of pressure and volume of the screw compressor

Study of dry and oiled lubrication in screw compressor

The anticipated model of screw compressor for refrigeration system (Liu et al., 2012)[9]. The anticipated data is compared with the experimental data with considering error for volumetrically displacement, input power at full load and partial load condition and vapour injection mass flow rate. This model will be use for creating volumetric ration of a screw compressor. Once scheming the numerical data, vapour injection is concentrated for the performance. Completely different volume ration was tested and differentiated the performance with and while not vapour injection.

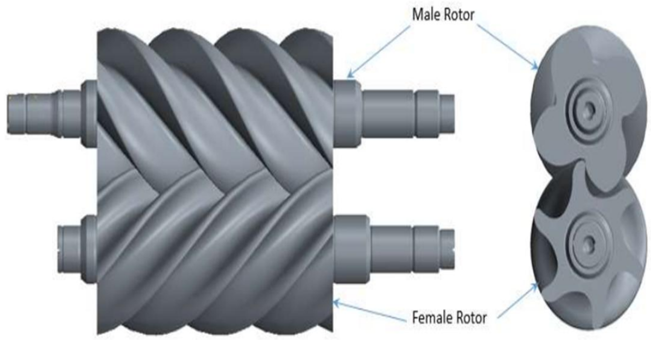

Figure-3 Screw compressor moving parts male rotor and female rotor

This work analysed a thermodynamic model of the working process in a water-injected twin screw compressor, in which the heat and mass transfer between liquid water and steam (Tian et al., 2017)[10]. As shown male and female rotor (Fig-3), its accuracy is validated by experimentally recorded p-v indicator diagram. The proposed model simulates and studies the performance of the compressor.

This paper describes two high-efficiency oil-free screw compressors designed to supply dry air (Stosic et al., 2001)[11]. Its design is based on the 'N' rotor profiles created by the author. The optimal size and speed of the rotor, as well as the shape and location of the intake and exhaust ports, were determined through mathematical modelling taking into account the constraints imposed by the selection of bearings and seals needed to maximize endurance and reliability. Together the two machines cover the discharge range from 350-1000m3/h. prototype testing showed that both the volumetric and adiabatic efficiencies of these machines were higher than the published values of any compressor. This confirmed the advantages of both the rotor profile and the construction method.

Sr.no	Name of the investigator	Focus of the research work	Key findings / results
1	Jinghui Liu	Numerical calculation and improvement with considering with or without vapour injection	The slide valve of 3.3 built in volumetric ration have a best performance for without (vapour injection) VI and T 2.9 higher efficiency got with VI.
2	Yafen Tian	Optimization of rotor and rack profile	A family of two compressors based on “N” profile rotors with a 3/5 configuration has been developed for dry air delivery by Drum-International to cover air delivery in the range of 300- 1000m3 /min. Extensive testing has shown that their performance is superior to that of all known compressors of similar application and similar size.
3	N Stosic, I K Smith and A Kovacevic	Simulated and experiment work compared	The compressor performance is simulated and studied. According to the simulation results, water injection can increase the volumetric efficiency 5% and adiabatic indication efficiency 6%

Table-2 summary of dry and oiled lubrication of the screw compressor

Study of various leakages in screw compressor

The researcher elaborated mathematical models including leaks and heat exchangers (Wang et al., 2019)[12]. The analytical data are validated with the measured data. In addition, some assumptions are made to simplify the computation of the simulation process Different leaks are considered and compared. The liquids flowing through the discharge vessel are also taken into account as leakage for the calculation process. the higher the RPM, the higher the flow rate and the leak rate will be a smaller percentage of the total flow rate. The experimental and the simulated p-v diagram show almost the same results. The simulation error was around 2% which is acceptable.

J S Fleming analysed the leakage through each route using the developed mathematical model (Fleming & Tang, 1995) [13]. Analytical techniques are proposed and experimental methods are discussed. The different rotational speed in the leakages is taken into account. Detailed information about the leakages are given. The cusp hole which has a small net leakages rate, has a small effect in the volumetric efficient but a large effect on the displayed isentropic efficient. The contact line has the greatest impact on the volumetric efficiency which is reduced by 4.77%, and the isentropic indicated efficient is around 3%. The reason they result in such a large reduction in volumetric efficiency is due to the comparatively large area of the compression start blowhole and he large rotor endplay at the suction end.

The Analyses done on leaks between lobs (Patel & Lakhera, 2021)[14]. The number of leakage flows depends on the size and shape of the free space, as well as various geometric and operational parameters. Leakage flow rates between lobes are estimated at different sizes and pressures. As a result, using an analytical iterative method, it is significantly smaller than the mean deviation used in the isentropic nozzle equation. The study confirmed that the iterative method (for interlobe leak rate prediction) can be preferred over the isentropic nozzle equation method. Due to the pressure difference and clearances leakage through the gaps occurs. In the present work, the upstream pressure is varied and the downstream pressure is maintained at atmospheric pressure to maintain the pressure ratio and simulate interlobe leak conditions.

The leak occurs due to the clearance space and pressure differential between the two pressurized chambers (Widell & Eikevik, 2010)[15]. In this work the numerical and mathematical models for different leaks in the twin screw compressor are presented. An iterative method for estimating the leakage, taking into account the gap geometry, friction and local resistance. An experimental setup is presented that can be used to further investigate these leaks. The performance parameters of the twin screw compressor largely depend on the leakages, which in turn depends on the gap dimensions in the bulk modules. Many researchers focused on the energy efficiency of the twin screw compressor and studied the impact of these clearances on compressor performance. Rotor tip housing leakages numerical simulated the rotor tip housing leakages using 2D model of the clearance gap. Three different models of the turbulence of different complexity used to find out the leakages flows between two chambers with different pressures.

The leakage mass flow rates predicted using described three methods and the results found in the range of 0.034 kg/s to 0.038 kg/s. The leakage rates found consistent for all the three models with fine grids. The k-ε (as dependent on the grid density) needs more computational efforts to get the comparable results obtained by other two methods.

The system used 5 screw compressors and ammonia as refrigerant, with slide valves to regulate the compressors to adjust their cooling capacity to the product freezing loads(Patel & lakhera, 2021b)[16]. The different leakages of the screw compressor shown represent the area where it can be considered (Fig-4). The optimized operation was carried out with and without a frequency converter. The behaviour of the compressors was analysed and described and part load capacity curves were constructed for each of the screw compressors in the system. The coefficient of performance (COP) was, calculated from cooling capacity and energy consumption. Compressors often ran in the partial load range, which led to high power consumption. The results showed that most of the electricity can be saved on days when not all tunnels are loaded. Systems like this use a lot of energy even at lower production rates as the compressors are designed to run as efficiently as possible.

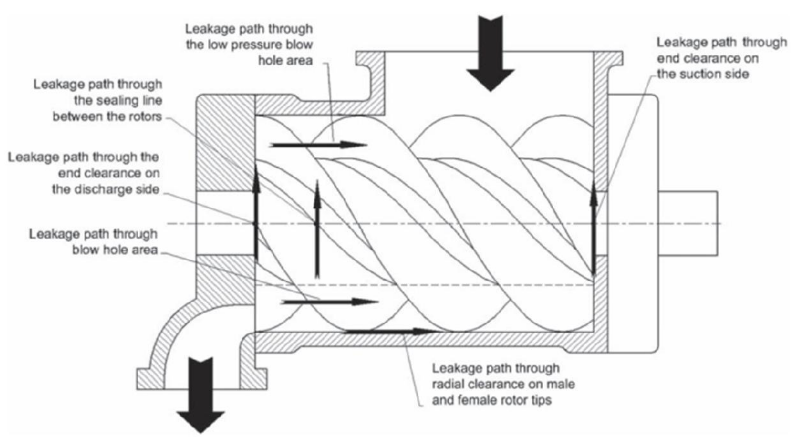

Figure-4 A cross section of screw compressor showing the location of various type of leakages

Sr. no	Name of the investigator	Leakage type	Focus of the research work / methodology used	Key findings/ results
1	Chuang wanga	Discharge end face clearance, rotor tip , start blow hole, suction end face and contact line	Mathematical model compared	The mathematical model is accurate enough and can be used to calculate the internal characteristics of the compressor. A comparison between leakages at different speeds shows that the exhaust end clearance has a larger impact on the specific indicated power, while the blowhole has smaller impact on efficiency
2	J s fleming	Cusp blow hole	Simulation analysis	The computer program uses the tested data to show that the predication is good, while the cusp hole has a very small effect on the volumetric efficient. It has a very significant effect on the stated isentropic efficacy. By changing the leakage pattern, a significant improvement in isentropic indicated efficiency is achieved although the improvement in volumetric efficacy is not large.
3	H h patel	Interlobe leakage	Use of iterative method	Adiabatic and volumetric efficiencies are affected by blade clearance, which is critical to the safe and reliable operation of a twin screw compressor. An unwrapped interlobe distance approximated a rectangular distance in this study.
4	Kn widell, t eilevik	Slide valve	Reducing refrigeration capacity with slide valve regulation and compressor speed	It can be seen from this that varying compressor speed gives a more energy efficient operation than slide valve regulation.
5	H h patel, vj lakhera	geometry of the clearance, friction and local resistances	Energy efficiency	The presented test rig can be used to collaborate and improve the leakage prediction models in screw compressors.

Table-3 Study of various leakages in screw compressor

Study of Pressure Losses in the Screw Compressor

The operation of the screw compressor is based on volume changes in three dimensions, which makes the working process very complex (H. Wu et al., 2019)[17]. To facilitate simulation and reflect the working process of the compressor, the study divided the overall fluid modelling into six domains: the suction domain, the screw domain, the discharge domain, the suction lift domain The discharge clearance domain and oil injection control. The grid density of the radial pitches has little impact on the compressor performance and pressure, this grid density of the radial pitches at 12 and then increased the circumferential pitches, also considered the angular pitches and the axial grids. The grid independence study also showed that the angular pitch had an obvious impact on the maximum pressure. After setting the angle per steps to 1°, the maximum pressure changed only slightly, but the time required increased significantly as the network density increased.

Finally, with full consideration of the deviations, the grid density with an axial size of 1 mm and an angle of 1 degree was used for the investigations of this work. The suction flow characteristics change periodically as a result of the variation in suction area and suction speed, so that the suction pressure pulsations become lower than the discharge pulsations. In addition, since the gas density in the discharge cavity is much higher, discharge pressure pulsations are stronger than those caused by suction gas pulsations. Therefore, the pressure pulsations in a screw compressor are considered to be the main source of noise.

Based on the findings, there are some recommendations:

1. In order to further reduce the noise level of the screw compressor, it is necessary to reduce the pressure pulsation energy acting on the casing of the screw compression section. In the high-pressure pulse position, it is advisable to make the compressor rotor housing stiffer or thicker. Then the pressure pulsations decrease. This aspect is worth further investigation.
2. If the oil injection outlet is in the axial location, especially in high oil flow conditions, it would be better to consider an additional drawing to reduce or eliminate the impact of the fluid hammer.

Sr.no	Name of the investigator	Approach	Key findings/results
1	Huagen Wu	The twin-screw domain were generated by the professional mesh tool SCORG.	The highest pulsation level occurs on the location where can record the whole discharge process of the internal ports

Table-4 Study of pressure losses in the screw compressor

Optimization of rotor profile and geometry

The information of lobe shape specification and specializes in a brand new profile of lobe which yields a bigger cross-sectional area and shorter sealing line ensuring in a better transport charges for the same tip speed (Stosic et al., 2011) [18]. A properly proven mathematical model turned into used to decide the optimal profile of the compressor housing size and compressor ports to achieve the superior compressor.

The deformation of the casing are different than the root deformation (Husak et al., 2018)[19]. The biggest deformation values for casing are 200 μm and it happens with inside the discharge zone. This end result indicates that casing enlargement will make a few losses area of the enlargement of the rotors. However because of slight extrude with inside the role of rotor axis at the release, the compressor factors will no longer are available and compressor will continue working correctly.

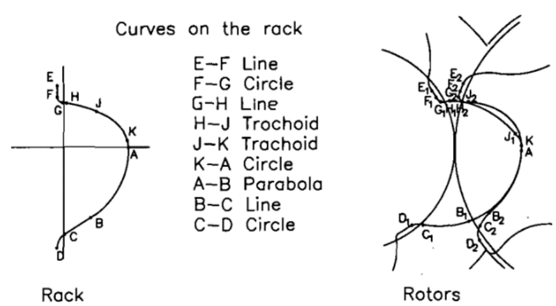

Figure-5 N rotor 5/6 primary profile on a rotor rack and rotor profile

The paper describes the design of a high-performance twin-screw compressor with new rotator profiles with a changes in the (Fig-5) tooth profile (Stošić et al., 1997)[20]. A properly validated mathematical version of the compression technique within high-quality displacement machines become used to decide the best rotor length and speed, the quantity rotation, and the oil ,injection and jet diameter. In addition, present day layout ideas along with an open suction port and easy publicity of the release port had been included, collectively with advanced bearing and seal specification, to maximise the Compressor performance. The prototype become exanimated and as compares with the quality compressor presently at the market.

The increasing need for efficient screw compressor requires economic and excessive efficiency rotor designs of Screw compressors (Wu & Fong, 2008)[21]. In order to layout, a powerful rotor rack, pitch, addendum height, rack-Coordinates, and meshing condition. An appropriate process for optimization of the screw compressor shape ,size , and size is defined hear, which ends up in maximum suitable layout compressor as a consequence designed achieve better delivery rates and higher efficiency then the ones that use conventional approaches.

A technique for the technology of the profile of dual screw compressor rotors from a meshing line is analytically derived (Zaytsev & Ferreira, 2005) [22]. The answer acquired relies upon the most effective on the distance among the rotor axis, the lobe quantity of each rotor, and the given meshing line description. Requirements of the meshing line are indexed and an evaluation is performed to achieve the greatest profile design. Application of the technique is demonstrated.

Sr. no	Name of the investigator	Approach	Key findings /Results
1	Nikola Stosic, Ian K Smith, Ahmed Kovacevic and Elvedin Mujic	Simulation with changing in some parameters	The simple rotor design made but to produce stronger and lighter rotor with higher displacement and lower contact stress can have a future scope
2	Ermin Husak	Numerical and simulation	Temperature values for the casing are highest around discharge port. Different region have a different deformation, where suction zone have a lower deformation than the discharge zone
3	N. Stošić	Mathematical model and optimized prototype	The high efficiencies obtained on test confirm their validity. It should be noted though that attention to the improvement of every detail of design such as the ports, the oil-injection system and the bearings all contributed to the potential for improvement offered by the novel high-throughput involute rotors. Also, it must be added that recent advances in the development of advanced low-friction rolling-element bearings contributed to the result.
4	Yu-Ren Wu and Zhang-Hua Fong	Mathematical model for design an effective rotor rack	Optimisation of screw compressor geometry has been performed to establish the most efficient rotor design. This paper numerical solution and calculation enables optimum screw compressor flow power and compressor efficiencies. Each segment on the rack is given at least one instinctive adjustable parameter for modifying the generated rotor profile. As shown by the numerical formulation the proposed design method is able to improve the performance of twin-screw compressor. Rack-generated profiles of rotors which is used in the paper explains optimisation may permit both better delivery and higher efficiency.
5	D. Zaytsev and C.A. Infante Ferreira	Profile generation from a meshing and analytically solution	The proposed method is easier to implement. The method presented helps to develop compressor rotors with reduced length of the contact line and small blowhole area, which will increase the compressor efficiency. With this method it is possible to predict the rotor sliding velocity at the contact point before the profile has been generated, which is helpful for wear analysis. Moreover, the method permits the minimisation of close-trapped volumes, the critical aspect for compressors operating with liquid.

Table-5 Optimization of rotor profile and geometry

Grid generation and Computational fluid dynamics (CFD) analyses of the screw compressor

Three grid deformation procedures were evaluated: diffusion equation mesh smoothing, user determined nodal displacement, and key-frame remeshing. Key-frame re-meshing has several drawbacks (rane et, all, 2013)[23]. It necessitates time-consuming pre-processing, has limited application to complicated meshes, and results in mistakes in computed variable conservation. It was determined that specific tools for CFD grid creation are necessary for sophisticated screw machines. Due to the complexity of the numerical mesh, no attempts were made to use Key-Frame Re-meshing to solve flow within a twin screw compressor. However, it was possible to demonstrate a suitable method for grid deformation solution in screw compressor CFD analysis by utilizing a customized grid generator and applying User Defined Nodal Displacement. As a result, custom tools to generate CFD grids for complex screw machines like single screw, variable pitch, and tri-rotor screw machines will need to be developed for future work. The solvers' User Defined Nodal Displacement grid deformation strategy will be made easier by these grids.

The study describes an algebraic grid generation technique for unstructured grids, as well as the Finite Volume Method (FVM) for variable pitch and variable profile screw machines (rane et, all,. 2014)[24]. The grid generation approach was tested on an oil-free air compressor with 3/5 lobe "N" profile rotors. The results were acquired by calculations using a commercial CFD package. The grid generation technique generates mesh of the requisite quality, and CFD results are provided to evaluate the performance of constant pitch, variable pitch, and variable profile rotors. For the same pressure ratio, variable pitch and variable profile rotors produce a steeper internal pressure increase and a bigger discharge area. In high pressure domains, variable pitch rotors minimise sealing line length.

Study demonstrates how it may be expanded to incorporate non-traditional rotor designs, such as those with variable lead or profile variation, as well as internally geared machines with conical rotors (rane et, all,. 2019)[25]. Other configurations that may be made with this advancement include dual gate rotors to boost volumetric displacement or twin lead, high wrap angle rotors for very high pressure differences and vacuum applications. A water-injected twin screw compressor case study is presented to show its utility for both comprehensive flow analysis and design.

The improvement in grid quality in crucial areas like the interlobe space, radial tip, and core of the rotor is compared using an analysis of an oil-injected twin screw compressor (rane & kovacevic, 2017)[26]. The robustness of the numerical solution and the quality of the grid are both significantly enhanced by the proposed approach, which combines algebraic and differential grid generation. An oil-injected twin screw compressor analysis is presented to compare the improvements in grid quality in crucial areas like the interlobe space, radial tip, and core of the rotors. Huge improvement in the lattice quality and power of mathematical solver with higher request shift in weather conditions plans has been gotten with this new twisting cross section. The simulation's outcomes provided a stunning illustration of the gas-oil interaction in the compression chamber. The effects on sealing caused by the high oil concentration in leakage gaps and the interaction of the phases, oil distribution, heat transfer between gas and oil, were well captured.

The rotors deform as a result of the significant pressure and temperature changes brought about by the compression process in screw compressors (Kovacevic, A., Stosic, N., Smith, 2022)[27]. A 3-D numerical approach that simultaneously calculates flow and deformation has been developed to identify this effect. A computer program known as SCORG is attached to a commercial CCM software package to generate a numerical grid for both the solid and fluid domains. This includes a mathematical procedure. As a result, the effect of rotor distortion on compressor performance is presented. An entire three dimensional reproduction has been completed to decide how tension and temperature changes make inward contortion inside screw blowers and accordingly influence their execution. While a rise in temperature can result in an increase in delivered flow and efficiency, a rise in pressure has negative effects. The results demonstrate that the compressor's use determines the rotor deformation. Therefore, it must be taken into account in each individual compressor design.

Sr. no	Name of the investigator	Focus of the research work	Key finding/ results
1	Sham rane, Ahemed, Nikola and madhulika.	Pitch rotors, variable pitch rotors and variable profile rotors.	The research revealed that changing the rotor lead allows for a bigger discharge port area, reducing throttling losses, and increases volumetric efficiency by shortening the sealing line in the high pressure zone. Analysis of various profile rotors revealed a sharper internal pressure rise, but no benefit in sealing line length or blow-hole area with this rotor size. The increased root diameter of female rotors with changeable profile undoubtedly aids in the production of strong rotors for high pressure applications. These grid generation advancements provide new opportunities for further exploration of flow behaviour and improvements in machine performance through the use of CFD.

2	Sham rane, Ahemed and Nikola	flow analysis and rotor design	The availability of a computational grid for such screw rotors currently allows for the evaluation of the flow and temperature field in these machines' operating chambers. Additional 3D CFD methods that can give robust grid re-meshing algorithms or meshless methods for flow calculation in these machines' complicated deforming domains will also need to be developed.

Design of Screw Compressor Casing

In this research, (Husak et al., 2018)[19] a numerical solution that integrates the solution of the fluid field from Computational Fluid Dynamics (CFD) and Finite Element Analysis (FEA) of solid components is utilised to determine deformations of the compressor elements. The temperature field produced from CFD is extracted and applied to the surface of the solid components, where it is averaged over time and used as boundary conditions for solid body calculations. The FEM study done in ANSYS produced optimistic findings that may be utilised to analyse changes in compressor clearances.

Sr.no	Name of the investigator	Focus of the research work	Key findings /Results
1	Ermin husak	Analysis of rotor and casing considering pressure and temperature difference	It is demonstrated that the results of a CFD calculation or a chamber model may be utilized to average the temperature on the rotor surface and to map the boundary conditions for a FEA study. According to the FEA study, the operating clearances in different parts of the compressor would vary differently due to the variable nature of the deformation of the rotors and casing. Work is being done to establish a reliable and rapid approach for analysing the influence of a change in clearance on the performance of a screw compressor.

II. CHALLENGES AND RECOMMENDATIONS

The performance of the screw compressor is well understood and examined when leakages, rotor profile, and other aspects are taken into account. Several tests and simulations were carried out to investigate the influence of temperature and pressure on compressor efficiency. For improved performance, various leakages were also explored. Although, further study can be done on individual leakages. The earlier experimental data can assist to enhance the simulation result and simplify the test setup for chamber while taking the leakages and rotor profile into account.

1) The pressure analyses and observation of the actual pressure in the compressor is the challenges which need further study to obtain the dynamic pressure data.
2) Because the internal discharge ports have insufficient discharge area, there is obvious "over compression" at the nominal working state, which can be reduced for improved efficiency. It is worthwhile to conduct further research on this subject.
3) The clearance can be reduce by changing the parameter of the tooth profile and design which leads to further research to acquire the higher pressure at discharge and no deformation of the profile.

III. CONCLUSION

Screw compressor efficiency is strongly reliant on rotor shapes and clearance distribution. It is popularly held, though incorrectly, that little can be done to increase screw compressor efficiency. To achieve the optimum results, however, all other compressor components, such as the housing ports, bearings, seals, and lubrication system, must be thoroughly examined. There is even more room for improvement if all of these elements are examined concurrently by using optimization processes in the design process. Using modern rotor generation methods, such operations will result in customised compressor designs tailored to each application, with stronger yet lighter rotors that generate larger displacements and are more compact and efficient. Other areas that require additional investigation include pressure measurement, the use of self-lubricated bearings, and application to specific fluids (such as hydrogen or helium) where experimental data and procedures lead to improvements in simulation modelling.

REFERENCES

[1]. Kovacevic, A., Stosic, N., & Smith, I. (2002). The influence of rotor deflection upon screw compressor performance. *Vdi Berichte*, *1715*, 17-28.

[2]. Dmitriev, O., & Arbon, I. M. (2017, August). Comparison of energy-efficiency and size of portable oil-free screw and scroll compressors. In *IOP Conference Series: Materials Science and Engineering* (Vol. 232, No. 1, p. 012057). IOP Publishing.

[3]. Read, M. G., Smith, I. K., & Stosic, N. (2017, August). Internally geared screw machines with ported end plates. In *IOP Conference Series: Materials Science and Engineering* (Vol. 232, No. 1, p. 012058). IOP Publishing.

[4]. Wu, W., Hu, C., Hu, J., Yuan, S., & Zhang, R. (2017). Jet cooling characteristics for ball bearings using the VOF multiphase model. *International Journal of Thermal Sciences*, *116*, 150-158.

[5]. Kovacevic, A., & Stosic, N. (2016). CFD analysis of oil flooded twin screw compressors.

[6]. Peng, X., Xing, Z., Cui, T., & Li, L. (2002). Analysis of the working process in an oil-flooded screw compressor by means of an indicator diagram. *Proceedings of the Institution of Mechanical Engineers, Part A: Journal of Power and Energy*, *216*(6), 465-470.

[7]. Xueming, H., Jin, D., Meiping, W., Hongyuan, L., & Chenggang, L. (2015). The Three-Dimensional Numerical Simulation and Experimental Research on Screw Compressor. *Advances in Mechanical Engineering*, *7*(1), 189579.

[8]. Wu, H., Lin, K., Huang, H., Xiong, B., Zhang, B., & Xing, Z. (2020). Research on Effects of Vapor Injection on Twin-screw Compressor Performance. *International Journal of Refrigeration*, *118*, 483-490.

[9]. Liu, J., Li, Q., Wang, F., & Zhou, L. (2012). A new model of screw compressor for refrigeration system simulation. *International journal of refrigeration*, *35*(4), 861-870.

[10]. Tian, Y., Shen, J., Wang, C., Xing, Z., & Wang, X. (2017). Modeling and performance study of a water-injected twin-screw water vapor compressor. *International Journal of Refrigeration*, *83*, 75-87.

[11]. McCreath, P. S. N. S. I. K. A., Stosic, N., Kovacevic, A., & Smith, I. K. (2001, September). The design of efficient screw compressors for delivery of dry air. In *International Conference Compressors and Their Systems, London*.

[12]. Wang, C., Xing, Z., Chen, W., Sun, S., & He, Z. (2019). Analysis of the leakage in a water-lubricated twin-screw air compressor. *Applied Thermal Engineering*, *155*, 217-225.

[13]. Fleming, J. S., & Tang, Y. (1995). The analysis of leakage in a twin screw compressor and its application to performance improvement. *Proceedings of the Institution of Mechanical Engineers, Part E: Journal of Process Mechanical Engineering*, *209*(2), 125-136.

[14]. Patel, H. H., & Lakhera, V. J. (2021, February). Modelling of leakages in rotary twin-screw compressor. In *IOP Conference Series: Materials Science and Engineering* (Vol. 1070, No. 1, p. 012114). IOP Publishing.

[15]. Widell, K. N., & Eikevik, T. (2010). Reducing power consumption in multi-compressor refrigeration systems. *International Journal of refrigeration*, *33*(1), 88-94.

[16]. Patel, H. H., & Lakhera, V. J. (2021). An experimental technique to simulate and measure leakages in twin-screw compressor. *Engineering Research Express*, *3*(1), 015024.

[17]. Wu, H., Huang, H., Zhang, B., Xiong, B., & Lin, K. (2019). CFD simulation and experimental study of working process of screw refrigeration compressor with R134a. *Energies*, *12*(11), 2054.

[18]. Stosic, N., Smith, I. K., Kovacevic, A., & Mujic, E. (2011). Geometry of screw compressor rotors and their tools. *Journal of Zhejiang University-SCIENCE A*, *12*(4), 310-326.

[19]. Husak, E., Kovacevic, A., & Rane, S. (2017, May). Numerical analysis of screw compressor rotor and casing deformations. In *International Symposium on Innovative and Interdisciplinary Applications of Advanced Technologies* (pp. 933-940). Springer, Cham.

[20]. Stošić, N., Smith, I. K., Kovačević, A., & Aldis, C. A. (1997). The design of a twin-screw compressor based

DOI: 10.48175/IJARSCT-7836

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Impact Factor: 6.252
Volume 3, Issue 1, January 2023

on a new rotor profile. *Journal of Engeering Design*, *8*(4), 389-399.

[21]. Wu, Y. R., & Fong, Z. H. (2008). Rotor profile design for the twin-screw compressor based on the normal-rack generation method. *Journal of Mechanical Design*, *130*(4).

[22]. Zaytsev, D., & Ferreira, C. I. (2005). Profile generation method for twin screw compressor rotors based on the meshing line. *International Journal of Refrigeration*, *28*(5), 744-755.

[23]. Rane, S., Kovacevic, A., Stosic, N., & Kethidi, M. (2013). Grid deformation strategies for CFD analysis of screw compressors. *International Journal of Refrigeration*, *36*(7), 1883-1893.

[24]. Rane, S., Kovacevic, A., Stosic, N., & Kethidi, M. (2014). Deforming grid generation and CFD analysis of variable geometry screw compressors. *Computers & Fluids*, *99*, 124-141.

[25]. Rane, S., Kovačević, A., & Stošić, N. (2019). Grid generation for CFD analysis and design of a variety of twin screw machines. *Designs*, *3*(2), 30.

[26]. Rane, S., & Kovačević, A. (2017, August). Application of numerical grid generation for improved CFD analysis of multiphase screw machines. In *IOP Conference Series: Materials Science and Engineering* (Vol. 232, No. 1, p. 012017). IOP Publishing.

[27]. Kovacevic, A., Stosic, N., Smith, I.: The influence of rotor deflection upon screw compressor performance. In: Conference on Screw Type Machines VDI-Schraubenmachinen, Dortmund, Germany, September 2002, pp. 17–28 (2002)

BIOGRAPHICAL NOTES

Mr. D.N Valand Born in Vadodara in India. He Graduated From Vadodara Institute Of Engineering, Vadodara In 2019 And Student Of ME CAD/CAM Of Government Engineering College, Dahod. His Areas of Interest Are Design Manufacturing and Renewable Energy.

Dr. K Bhabhor Currently Working as Assistant Professor in the Department Of Mechanical Engineering at Government Engineering College Dahod under the Gujarat Technological University. Published More Than 20 Research Paper In Good Journals. His Area of Interest Are Thermal Engineering, Solar Energy and Energy Saving.

Dr D.B. Jani Received PhD in Thermal Science (Mechanical Engineering) From Indian Institute of Technology (IIT) Roorkee. Supervisor at Gujarat Technological University (GTU). Published More Than 100 Research Articles In In International Conferences And Journals. Presently He Is Associate Professor At Gujarat Technological University, GTU, Ahmedabad (Education Department State Of Gujarat, India, Class-I, Gazetted Officer. His Area Of Research Is Desiccant Cooling, ANN, TRANSYS, and Energy.

Mr.T.Gandhi Currently Working as Assistant Professor in the Department Of Mechanical Engineering at Government Engineering College Bhavnagar under the Gujarat Technological University. His Area Of Interest Is Thermal Engineering, IC Engine And Automobile And Manufacturing.