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KINEMATICS OF FLOW IN THE IMPELLER OF CENTRIFUGAL PUMPS

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ANNOTATION

This article analyzes in detail the kinematics of fluid motion inside the impeller of centrifugal pumps. The absolute, relative and peripheral velocity components of the flow, velocity triangles, flow angles and their effect on efficiency are considered. Flow disturbances, separation zones, twisting motions (vortices) and methods for eliminating them are also covered. Based on kinematic analysis, the possibilities of determining theoretical pressure using the Euler equation and other hydraulic formulas, and evaluating flows using computer modeling (CFD) are also considered. The article is intended for engineers and technical specialists involved in pump design, hydraulics and energy efficiency.

Key words: Centrifugal pump, impeller flow, flow kinematics, relative velocity, absolute velocity, blade angle, velocity triangles, radial flow, tangential velocity, fluid dynamics, flow path, rotational motion, hydraulic efficiency, slip factor, vortex flow theory.

INTRODUCTION

Centrifugal pumps are widely used in industry, utilities, water supply and heat energy systems. The efficiency and stability of such pumps directly depend, first of all, on the kinematics of internal flows - in particular, the flow in the impeller. This article

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discusses the speed conditions, directions of flows inside the pump, the causes of failures and methods for their calculation.

From the center escape of the pump work principle

Pump worker wheel using an electric motor turns into . Liquid wheel from the center (entrance (through the eye) and rotation under the influence to the periphery (external) diameter) moves . Centrifugal power liquid particles additional kinetic energy gives , this energy later pressure to the energy turns .

Worker on the wheel currents types

Liquid worker on the wheel movement as follows classification possible :

- **Login flow** – in the axial direction , usually one kind pressure under
- **Radial flow** – vanes between , wheel to the cycle related
- **Peripheral (tangential) motion** – rotation because of to the surface comes
- **Spiral (vortex) flow** – on the periphery it will be , this energy to their losses reason will be

The flow cinematic analysis

1. Speed components

Worker on the wheel every one liquid of a particle movement 3 main speed from vector consists of :

Character	Description
c ⃗ \vec { c } c	Absolute velocity – of the fluid general speed

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Character	Description
u ⃗ \vec { u } u	Rotational (peripheral) speed – working wheel rotation because of
w ⃗ \vec { w } w	Relative velocity – of the fluid to the wheel relatively speed

They between dependency following vector equation with is expressed as :

c ⃗ =u ⃗ +w ⃗ \ vec {c} = \ vec {u} + \ vec {w} c = u + w

2. Speed triangles

Liquid entrance and exit at points every kind speed triangles has :

- **At the entrance (r_1):** stream mainly in the axial direction
- **At the output (r_2):** peripheral component increases

Exit triangular according to Aylor equation through of the pump giving pressure is defined as :

H= 1g(u2cu2−u1cu1)

This on the ground :

- uu u – rotation speed
- cuc_ { u } cu – peripheral component
- HH H – theoretical pressure (pressure)
- gg g – free fall acceleration

Flow corners and their importance

Worker wheel of the wings corners stream direction determines :

- **Incoming angle (β 1\beta_1 β 1)** – liquid to the wing how enters
- **Outgoing angle (β 2\beta_2 β 2)** – liquid wingtip how abandonment will

Flow compatibility (i.e. , flow angle and wings angle compatibility) – energy their losses reduces . On the contrary without **divorce** or **turn flow** appearance will be .

In the stream disorders and losses

1. Divorce zones

Wings along stream enough undirected if , the current from the wall separates – this **cavitation** , **energy loss** , and to **the noise** take is coming .

2. Turbulent flow

Big diameter and fast rotating on wheels stream It becomes turbulent . It is **viscous. losses** increases .

3. Slowing down zones

The wheel back in part stream speed decreases – this and **working being released pressure** reduces .

Hydraulic efficiency and stream kinematics impact

Pump general efficiency :

η = Useful powerTotal power \eta = \ frac { Useful power }{ General power } η = Total power Useful power

Kinematic malfunctions :

- Wrong wing corners

- The flow turn
- Vortex and turbulences

this factors **useful power reduces** , so **efficiency** reduces .

Flow kinematics calculation methods

1. Analytical methods

Closed formulas using calculation (e.g. , Euler) equation , Bernoulli equation).

2. Graphic methods

Speed triangles on the graph build and geometric analysis .

3. Computer modeling (CFD)

- Accurate 3D model (pipe , wheel)
- Speed fields , pressure gradients
- Cavitation and stream turn zones determination

Practical example (simplified)

Rotation speed : n=2900 rpm / min = 2900 Rotation corner speed :

ω =2 π n60=2 π · 290060≈303.5 rad /s

Peripheral speed :

u=r · ω =0.1 · 303.5=30.35 m/s

Outgoing cuc_u cu = 22 m/s Theoretical pressure :

H=19.81(u · cu)= 19.81(30.35 · 22)≈68.1 m

Conclusion

From the center escape pump worker on the wheel of the stream kinematics of liquid how movement , to him how much energy to be given and pump efficiency determines . Speed components correct analysis , flow direction optimization and cavitation of violations prevent to take through of the pump work deadline extends and energy is saved . Therefore , this issue not only theoretically , maybe important practical importance has .

REFERENCES

1. Quvondiqov, Q. (2023). On the Issue of Efficiency in the Transportation of Oil Products by Main Pipeline. International Journal of Trend in Scientific Research and Development (IJTSRD).
2. Quvondiqov, Q. (2021). Suv ta'minoti, oqova suv, gidravlika va suv resurslarini muhofaza qilish sohalarida yangi yutuqlar. X МЕЖДУНАРОДНАЯ НАУЧНО-ПРАКТИЧЕСКАЯ КОНФЕРЕНСИЯ.
3. Quvondiqov, Q. (2022). Gidtrotransport tizimlaridagi adgeziyani dispers sistemalarni modifikaцyalash orqali kamaytirish. Scienceweb academic papers collection.
4. Quvondiqov, Q. (2023). Magistral va undan tarqalagn quvurlar tizimini gidravlik hisoblash. ELEKTRON HISOBLASH MASHINALARI UCHUN YARATILGAN DASTURNING RASMIY ROʻYXATDAN OʻTKAZILGANLIGI TOʻGʻRISIDAGI GUVOHNOMA OʻZBEKISTON RESPUBLIKASI ADLIYA VAZIRLIGI,№ DGU 24340, Talabnoma kelib tushgan sana: 03.04. 2023 Talabnoma raqami: DGU 2023 2692.
5. Quvondiqov, Q. (2018). TTYMI talabalar turar joyidagi suv ta’minoti tizimlarining muammolari. Scienceweb academic papers collection.
6. Quvondiqov, Q. (2022). Quduqning siljishga, agʻdarilishiga va suzib chiqishiga boʻlgan turgʻunligini hisoblash uchun dastur. Scienceweb academic papers collection.

ISSN 2181-3187

7. Esanmurodov, S. (2023). On the Issue of Efficiency in the Transportation of Oil Products by Main Pipelines. International Journal of Trend in Scientific Research and Development (IJTSRD).

8. Quvondiqov, Q. (2021). Обоснование проведения реконструкции Бектемириских канализационных очистных сооружений г. Чирчика с целью повышения эффективности их работы. Scienceweb academic papers collection.

9. Бабаев, А. Р., & Умаров, У. В. (2023). МАҲАЛЛИЙ ХОМ АШЁЛАРДАН ТАЙЁРЛАНГАН ФИЛЬТРЛАРНИ ЮВИШ. Scientific Impulse, 1(10), 415-422.

10. Javokhir, O., Askar, B., Kuvonchbek, K., & Uchkun, U. (2023). Washing Filters Made From Local Raw Materials. Best Journal of Innovation in Science, Research and Development, 2(6), 281-288.

11. Quvondiqov, Q. (2023). MAHALLIY XOM ASHYOLARDAN TAYYORLANGAN FILTRLARNI YUVISH. Международный современный научно-практический журнал Научный импульс.

12. Quvondiqov, Q. (2023). Neft mahsulotlarini magistral quvurlar orqali tashishda nasos rejimi va nasos stansiyalarida elektr energiyasining xarajatlari. Замонавий архитектура, бинолар ва иншоотларнинг мустаҳкамлиги, ишончлилиги ва сейсмик хавфсизлик муаммолари.

13. Quvondiqov, Q. (2023). Neft va neft mahsulotlarini quvurlar orqali tashishda nasos va quvur liniyasining kombinasiyalashgan xususiyatlari. Замонавий архитектура, бинолар ва иншоотларнинг мустаҳкамлиги, ишончлилиги ва сейсмик хавфсизлик муаммолари.

14. Babayev, A. (2023). NEFT VA NEFT MAHSULOTLARINI MAGISTRAL QUVURLAR ORQALI TASHISHDA NASOS VA QUVUR LINIYASINING UMUMIY XARAKTERISTIKALARI. Замонавий архитектура, бинолар ва иншоотларнинг мустаҳкамлиги, ишончлилиги ва сейсмик хавфсизлик муаммолари.

15. Obidjonov, A., Umarov, U., Babaev, A., Quvondiqov, Q., & Umarova, D. (2023). Purification of borehole and domestic waters in rural conditions of Uzbekistan

ISSN 2181-3187

using filters and their hydraulic calculation. In E3S Web of Conferences (Vol. 401, p. 01084). EDP Sciences.

16. Umarov, U., Quvondiqov, Q., Obidjonov, A., Babaev, A., & Ochildiyev, O. (2023). Selecting wastewater treatment filters using local raw materials. In E3S Web of Conferences (Vol. 401, p. 03019). EDP Sciences.