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困油压力对齿轮泵流量脉动的影响分析

Influence analysis of trapped oil pressure on flow pulsation in external gear pumps

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作者	单位
李玉龙	成都大学工业制造学院，成都 610106
唐 茂	成都大学工业制造学院，成都 610106

中文摘要:

为考量困油压力对外啮合齿轮泵流量脉动的影响，以无侧隙和对称双矩形卸荷槽为例，基于泵排油区域封闭容积的精确计算，并结合困油压力的仿真与验证，给出了理想与实际两状态下瞬时流量的计算公式，并分析了流量脉动所涉及到的相关性能指标。结果表明，相对于无卸荷槽情况，理想状态下的卸荷槽能够极大地改善泵的流量脉动，案例参数下的平均流量提高了12.34%；流量不均匀系数降低了85.09%；在考虑困油以及相关泄漏量的情况下，有卸荷槽的流量脉动品质虽然比理想状态下有所下降，但仍比无卸荷槽时有很大的改善，案例参数下的平均流量提高了6.73%；流量不均匀系数降低了73.90%；高速时虽然存在较大的困油压力，但该压力却有利于流量脉动的改善，案例参数下的困油压力峰值虽高达9.7 MPa，但流量不均匀系数却降低了87.61%等。因此在流量脉动的计算中考虑困油因素很有必要，其结果也将更可靠更精确。

英文摘要:

Abstract: In external gear pumps with involutes gear pairs, the existing literatures did not consider the quantitative relationship between its trapped oil pressure and its flow pulsation. Therefore, this paper aimed at seeing clearly the influence of its trapped oil pressure on its flow pulsation with no backlash value of gear pairs and a pair of symmetrical rectangle relief grooves for relieving trapped oil pressure as an example, based on the swept area method for calculating closed area and a detailed analysis of trapped oil process inherent to external gear pumps. From an accurate calculation of the changed volume in the discharge side of gear pumps along with the meshing position variables, which was the curvature radius of meshing point on meshing contour of active gear, the formula for calculating flow pulsation and the related measurable indicators such as average flow rate and flow non-uniform coefficient were derived in a ideal state and an actual state. The ideal state was that no trapped oil pressure and no leakage flow rate from discharge side of pumps to suction side was considered in the calculation of flow pulsation; and the actual state was just in contrast to the ideal state, the trapped oil pressure and the leakage flow rate must be considered in the calculation of flow pulsation; at the same time in the calculation of flow pulsation, the trapped oil pressure was performed simulating calculation by a trapped oil model which was validated to be correct and reliable in the existing literature. Then the associated indicators with the flow pulsation such as average flow rate and flow non-uniform coefficient were analyzed, and some results and conclusion were obtained. All results from the paper indicated that, relative to no relief groove in pumps, the quality of flow pulsation with a relief groove was improved in the ideal state. In an especial case, the flow rate was increased by 12.34% on average, and the flow non-uniform coefficient was reduced by 85.09%. Compared with the ideal state, the quality of the flow pulsation was decreased in the actual state, but compared with no relief groove, the quality of the flow pulsation with a relief groove was improved in the actual state, in an especial case, the flow rate was increased by 6.73% on average, and the flow non-uniform coefficient was reduced by 73.9%. At the higher speed, there was a great trapped oil pressure, but it was helpful for improving the quality of the flow pulsation. in an especial case, in which the rotating speed was 5 000 revolutions per minute, the maximum peak value of the trapped oil pressure was up to 97 MPa , but the flow non-uniform coefficient was reduced by 87.61%. Finally, the trapped oil phenomenon was objectively shown to exist, so the important conclusion was summarized that the trapped oil pressure and the various related leakages from the trapped oil zone must be taken into account in the calculation of flow pulsation, and only then can the associated results with the flow pulsation be more reliable and more accurate. Although the paper was aimed at the calculation and analysis of flow pulsation with no backlash value and a pair of symmetrical rectangle relief grooves, the new method of calculating flow pulsation is suitable for any backlash value and any relief groove type.