



VRI COMPOSITES

MANUFACTURERS & FABRICATORS OF ENGINEERED MATERIAL SOLUTIONS

Composite Rotor Vanes

Matching Wear Resistance, Friction Behavior and Mechanics in Rotary Vane Vacuum pumps

WHAT IS A ROTARY VANE VACUUM PUMP

Rotary vane vacuum pumps create vacuum by continuously capturing, compressing, and discharging air or gas. This process relies on sliding rotor vanes that maintain contact with the pump housing as the rotor turns. Because these vanes are in constant motion and contact, their material properties have a direct impact on pump efficiency, service life, maintenance requirements, and overall reliability. Selecting the right composite vane material is therefore a key factor in achieving long-term pump performance.

Rotor vanes are small components with system-level influence. Their sliding contact helps define chamber volume and transport gas from inlet to outlet. Because the vane repeatedly moves within the rotor slot while its tip follows the pump chamber, material selection must address continuous sliding, oscillating contact, frictional heating and interaction with the metallic counterface.

HOW THE VANE WORKS

1 - EXTEND	2 - SEAL	3 - COMPRESS	4 - REPEAT
Rotation and centrifugal/contact forces move the vane toward the chamber wall.	The vane separates expanding and contracting working chambers.	Eccentric rotation reduces chamber volume and transports the gas.	Every revolution renews sliding contact at the tip, slot and counterface.

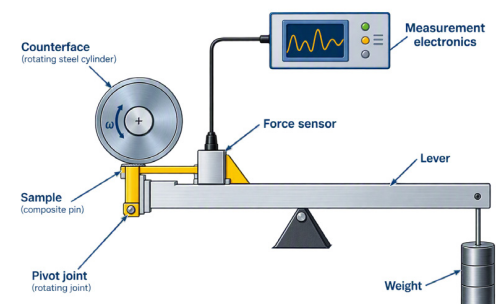
WHAT MATTERS IN A COMPOSITE VANE

WEAR RATE Low material loss helps preserve vane geometry and running clearances.	FRICITION Friction influences heat generation and drive losses, but does not alone predict wear.	COUNTERFACE Vane and steel surface form one tribological system; both wear rates matter.
MOTION TYPE Continuous, fretting and reciprocating motion can produce different rankings.	STABILITY Low scatter supports predictable behavior under a defined test condition.	QUALIFICATION Final selection requires testing in the intended pump, atmosphere and counterface condition.

FRICITION AND WEAR RATE TESTING

The source study compared five rotor-vane materials using complementary laboratory contacts: block-on-ring for continuous sliding against 100Cr6 steel, standard flexural strength testing according to ISO 178 and water absorption testing according to ISO 62. Each test has been carried out several times to get a statistically significant value. The primary outputs were the specific wear rate of both material partners and the coefficient of friction for the sliding test.

CONTINUOUS SLIDING		
RELATIVE SPEED	CONTACT PRESSURE	TIME
1 m/s (2.2 mph)	1 MPa (0.15 ksi)	20 hours



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Composite Rotor Vanes (cont.)

INTERPRETING THE COMPARATIVE RESULTS

No single value defines the best vane. The results show why wear of the composite, wear of the steel partner, friction and the mechanics must be interpreted together and in the context of the contact motion.

TEST RESULTS:

The detailed data set provides directly comparable wear and mechanical values for five grades under the same conditions. Lower values for the wear indicate less measured volume loss and/or lower friction under this specific laboratory contact; neither this data nor the mechanical values constitute a universal ranking.

Material	Composite wear rate ¹	Steel wear rate ¹	Friction coefficient μ	Flexural strength [MPa / ksi]	Water absorption [%]
AR 600 T23	4.82	0.247	0.15	160 / 23	0.3
Vetronite EGS T23	5.86	2.838	0.50	450 / 65	0.05
AR 600 P01	6.85	1.400	0.16	160 / 23	0.3
ACG 600 T23	7.35	9.099	0.26	130 / 19	0.35
Vetronite G11	8.80	8.190	0.53	400 / 58	0.06

¹ Specific wear rate as reported in the supplied dataset: $\times 10^{-5}$ mm³/Nm (that is volume loss per distance per contact force).

APPLICATION-ORIENTED MATERIAL POSITIONING

PRODUCT	OBSERVED STRENGTH	WHERE TO FOCUS QUALIFICATION
AR 600 T23	Lowest wear for the composite part and the steel counterpart. Also, the lowest mean friction.	Strong candidate where vane life and stable sliding are the primary design objectives.
AR 600 P01	Very low mean friction and comparatively low steel-partner wear in the detailed dataset.	Relevant where designers seek a balanced vane / counter face response under sliding contact.
ACG 600 T23	Intermediate mean friction in the detailed friction dataset.	Useful candidates where the intermediate values are sufficient for the application and the focus is more on economical pricing.
Vetronite EGS T23 / Vetronite G11	Highest mechanical properties and lowest water adsorption compared to the other materials.	Applicable where highest mechanical demands and low water adsorption are needed due to the size of the pump and / or the required vacuum level and for humid environments.

DESIGN TAKEAWAY

Select the tribological and mechanical system, not the vane in isolation. A technically sound qualification program matches the composite grade, surface condition, operating conditions and lubrication environment to the intended pump duty.

CONCLUSION

The study confirms that composite rotor vanes can be tailored to different pump priorities. AR 600 T23 stands out when measured wear resistance is the dominant criterion. AR 600 P01 shows an attractive low-friction and low-counterface-wear profile in the supplied friction data. ACG 600 T23 provide alternative, method-dependent performance profiles that can be a more economical solution than the pure aramid (AR) grades. Vetronite grades provide the highest mechanical properties with the lowest water absorption.

None of these results should be treated as a blanket acceptance or rejection: each grade can be assessed against the operating envelope and design priorities of the target vacuum pump.

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