Slovak Society of Chemical Engineering
Institute of Chemical and Environmental Engineering
Slovak University of Technology in Bratislava

PROCEEDINGS

52nd International Conference of the Slovak Society of Chemical Engineering SSCHE 2026

Hotel SOREA TRIGAN

Štrbské Pleso, Slovakia

May 26 - 29, 2026

Editors: Assoc. prof. Mário Mihaľ

ISBN: 978-80-8208-177-3, EAN: 9788082081773

Published by the Faculty of Chemical and Food Technology, Slovak University of Technology in Bratislava in Slovak Chemistry Library for the Institute of Chemical and Environmental Engineering; Radlinského 9, 812 37 Bratislava, 2026

Rychlá, V., Valenz, L.: Comprehensive experimental characterization of NeXRing #0.7 random packing, Editors: Mihaľ, M., In *52nd International Conference of the Slovak Society of Chemical Engineering SSCHE 2026*, Štrbské Pleso, Slovakia, 2026.

Comprehensive experimental characterization of NeXRing #0.7 random packing

Veronika Rychlá[1], Lukáš Valenz[1]

[1]*University of Chemistry and Technology, Technická 5, 160 00 Prague, Czech Republic*

e-mail: lukas.valenz@vscht.cz

Key words: Mass-transfer characteristics, Hydrodynamic performance, NeXRing packing

Random packings remain a key element of industrial absorption columns and gas-liquid contactors, where further improvements in hydraulic performance and mass-transfer efficiency are essential for reducing energy consumption while maintaining high process intensification. Among recent developments, the NeXRing packing family has attracted increasing industrial interest due to its advanced geometry, which enhances liquid distribution, lowers pressure drop, and increases effective interfacial area in comparison with conventional random packings. However, despite its practical relevance, open-literature experimental data for NeXRing packings, particularly for small-size elements, are largely unavailable.

This contribution presents a comprehensive and original experimental characterization of the hydraulic and mass-transfer properties of NeXRing #0.7 random packing under absorption operating conditions. To the authors' knowledge, this study provides the first complete publicly available dataset for this packing size. Hydraulic behaviour was investigated by pressure-drop measurements in an air-water system over a wide range of gas and liquid loads. Mass-transfer performance was evaluated using three well-established absorption systems: oxygen desorption from water to determine the liquid-side volumetric mass-transfer coefficient ($k_L a$), chemisorption of SO_2 into aqueous NaOH for the gas-side volumetric mass-transfer coefficient ($k_G a$), and chemisorption of CO_2 into aqueous NaOH to quantify the effective interfacial area (a). All mass-transfer characteristics were obtained using the subtraction method in order to eliminate end effects. Experiments were conducted in an atmospheric column with an inner diameter of 0.3 m, using packed-bed heights between 0.42 m and 1.3 m. The resulting experimental data were used to determine the hydraulic parameters (C_S, C_{Fl}, and $C_{P,0}$) and the mass-transfer parameters (C_L and C_V) of the Billet and Schultes (1999) model. The newly identified model parameters enable a reliable and validated description of NeXRing #0.7 performance, providing a solid basis for the design, comparison, and scale-up of absorption equipment utilizing this packing.

Comprehensive experimental characterization of NeXRing #0.7 random packing

Veronika Rychlá[1], Lukáš Valenz[1]

[1]*University of Chemistry and Technology, Technická 5, 160 00 Prague, Czech Republic*

e-mail: lukas.valenz@vscht.cz

Key words: Mass-transfer characteristics, Hydrodynamic performance, NeXRing packing

Abstract

Random packings remain a key element of industrial absorption columns and gas-liquid contactors, where further improvements in hydraulic performance and mass-transfer efficiency are essential for reducing energy consumption while maintaining high process intensification. Among recent developments, the NeXRing packing family has attracted increasing industrial interest due to its advanced geometry, which enhances liquid distribution, lowers pressure drop, and increases effective interfacial area in comparison with conventional random packings. However, despite its practical relevance, open-literature experimental data for NeXRing packings, particularly for small-size elements, are largely unavailable.

This contribution presents a comprehensive and original experimental characterization of the hydraulic and mass-transfer properties of NeXRing #0.7 random packing under absorption operating conditions. To the authors' knowledge, this study provides the first complete publicly available dataset for this packing size. Hydraulic behaviour was investigated by pressure-drop measurements in an air-water system over a wide range of gas and liquid loads. Mass-transfer performance was evaluated using three well-established absorption systems: oxygen desorption from water to determine the liquid-side volumetric mass-transfer coefficient ($k_L a$), chemisorption of SO_2 into aqueous NaOH for the gas-side volumetric mass-transfer coefficient ($k_G a$), and chemisorption of CO_2 into aqueous NaOH to quantify the effective interfacial area (a). All mass-transfer characteristics were obtained using the subtraction method in order to eliminate end effects. Experiments were conducted in an atmospheric column with an inner diameter of 0.3 m, using packed-bed heights between 0.42 m and 1.3 m. The resulting experimental data were used to determine the hydraulic parameters (C_S, C_{Fl}, and $C_{P,0}$) and the mass-transfer parameters (C_L and C_V) of the Billet and Schultes (1999) model. The newly identified model parameters enable a reliable and validated description of NeXRing #0.7 performance, providing a solid basis for the design, comparison, and scale-up of absorption equipment utilizing this packing.

Mass transfer measurement in the gas phase

To determine the volumetric mass transfer coefficients in the gas phase, the concentrations of the tracer (SO_2) in gas phase samples must be measured downstream and upstream of the packed bed. The apparatus used for the measurement was designed to collect samples just before the gas comes into contact with absorption liquid in the absorption column, and after the gas flow meter (orifice) on the gas outlet where SO_2 concentration in the bulk is homogeneous. To obtain $k_G a$ of the packed bed itself, net $k_G a$, it is necessary to implement a subtraction method, which requires measurements to be performed on two different packed bed heights. Packed bed heights of 0.55 and 0.84 m were utilized during the experiment. Dependence of $k_G a$ values determined on two packed bed heights on gas velocity is shown on Figure 1 for liquid load B = 20 m/h. As expected, end effects are more apparent on $k_G a$ values obtained with 0.55 m packed bed than on the ones obtained with 0.84 m. Values representing net $k_G a$ of the packing are the lowest ones.
Values of $k_G a$ for 5 different liquid loads ranging from 5 to 60 m/h obtained using the subtraction method are shown on Figure 2. The data were fitted using power functions with exponents ranging from 0.6 to 0.7, which is consistent with most published models. It is worth noting that the $k_G a$ values representing liquid loads of 20, 40 and 60 m/h are almost identical. This unusual phenomenon was confirmed by several repeated measurements. Since most mass transfer theories and models assume that k_G does not depend on the liquid phase flow rate, the increase in $k_G a$ values with the liquid flow rate must be caused by the dependence of effective interfacial area on the liquid load.

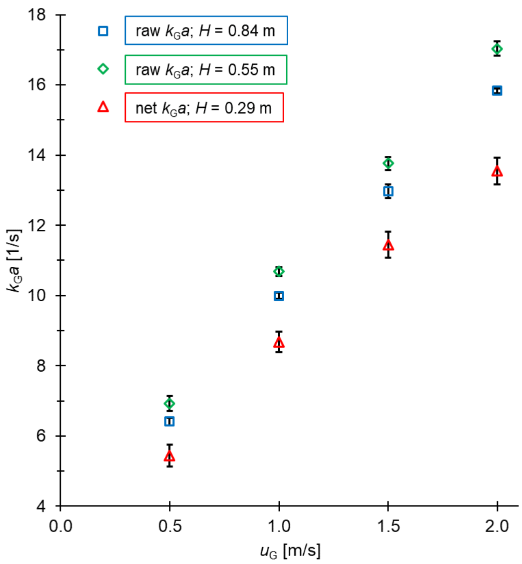

Figure 1: Dependence of $k_G a$ values on gas velocity, B = 20 m/h, error bars represent 95% confidence interval

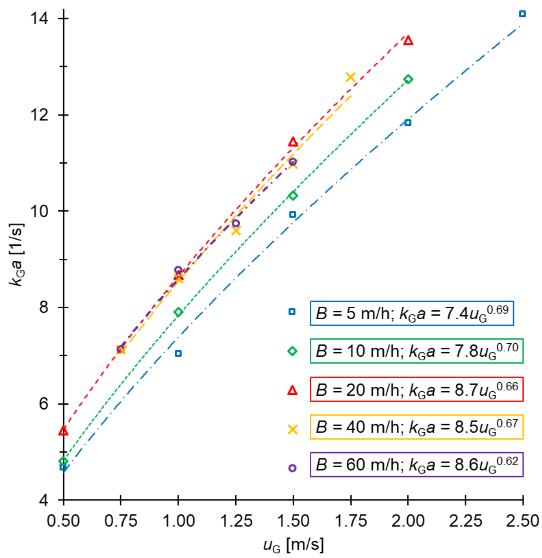

Figure 2: Dependence of $k_G a$ values on gas velocity for five different liquid loads

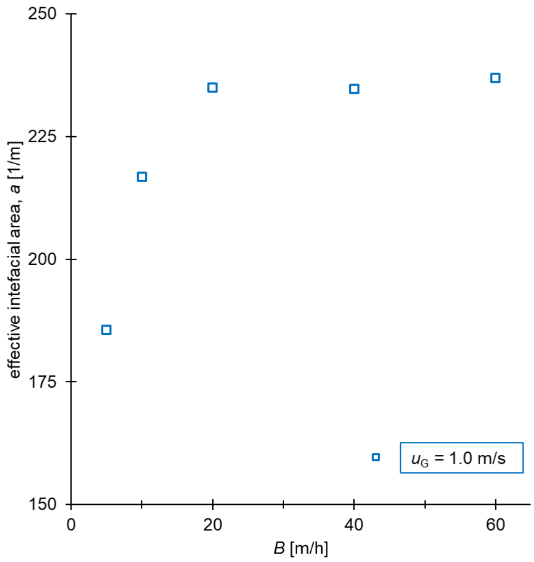

Figure 3: Dependence of "*a*" values on liquid load

If the above assumptions were correct, this behavior would have to be seen in the values of the effective interfacial area. This was again determined by the subtraction method at two packed bed heights of 0.4 m and 1.3 m. The resulting values as a function of the liquid load can be seen in Figure 3 for a gas velocity of u_G = 1 m/s. It is obvious that the effective interfacial area of the packing increases negligibly for liquid loads 20, 40 and 60 m/h. This confirms that the effective interfacial area in our absorption column has reached its maximum and is no longer increasing with the liquid phase flow rate, which is why $k_G a$ is independent of the liquid phase flow rate.

Conclusion

This study presents a consistent hydraulic and mass-transfer characterization of the NeXRing #0.7 random packing under absorption conditions. The specific pressure-drop data are well captured by the Billet & Schultes (1999) framework when flow-rate-specific constants are used, with average deviations near 2 % and maxima below 4 % - 5 % in the investigated range; models based on averaged constants exhibit higher bias, particularly at dry and highly irrigated conditions. Net gas-phase mass-transfer data show the expected insensitivity of k_G to liquid load once the effective area saturates, as confirmed by the weak increase of *a* beyond *B* = 20 - 60 m/h. For the liquid phase, fitting the Billet & Schultes model (1999) yields a multiplicative constant C_L=1.35 with an average relative deviation of ~10 %, consistent with values reported for earlier packing generations and in good agreement with the correlation by Song et al. (2018). Overall, NeXRing #0.7 combines low pressure drop with competitive mass-transfer performance, and the reported parameters enable predictive, rate-based design in the studied range.