Available online at www.sciencedirect.com

ScienceDirect

Procedia Technology 12 (2014) 375 – 381

Procedia Technology

The 7th International Conference Interdisciplinarity in Engineering (INTER-ENG 2013)

Hydrodynamics of apparatuses with preformed packing bodies

Zh. Serikuly[a,*], A. A. Volnenko[b], E. Ya. Kenig[c]

[a]*M. Auezov South Kazakhstan State University, Shymkent 160000, Kazakhstan*
[b]*M. Auezov South Kazakhstan State University, Shymkent 160000, Kazakhstan*
[c]*University of Paderborn, Paderborn 33098, Germany*

Abstract

The article describes the various types of preformed units of packed elements: cylindrical, sheet and ball. It is planned to do analyze of the hydrodynamic environment devices by the alteration of the gas flow rate and determination of the mode operation as well as researching of hydraulic resistance machines irrigated with regular packing depending on the vertical spacing between the elements of a packed and identifying opportunities to achieve regime simultaneous vortex. The equation for calculating the amount of the retained fluid for all the studied packed elements will be obtained as a result of the experimental data processing.

Keywords: preformed packing; interaction of the vortices; hydraulic resistance; amount of the retained fluid.

1. Introduction

Packing columns find application in the modern chemical, petrochemical, oil, gas, and other industries for processes of chemisorptions, absorption, distillation, extraction, gas cooling and liquid and gas separation.

Random packing of HY-PAK, CASCADE-RINGS, “Engchem” types and preformed packing of INTALOX, Sulzer, Koch, “Inzhehim”, Norton, “Vakupak”, “Glitch-Grid”, Mellapak, Mellapak Plus, Mellagrid types are widely

* Corresponding author. Tel.: +7-701-102-2422;
E-mail address: drzhan@mail.ru

doi:10.1016/j.protcy.2013.12.502

used as contact devices in chemical apparatuses [1-6]. Preformed packing has several advantages over random packing: it has a lower hydraulic resistance that allows extension of the range of gas velocities.

An entirely different principle of creating a regular gas-liquid layer is put in structures incorporated devices with a regular movable packing, in which the packing elements are strung on string with evenly spaced vertically and evenly spaced between the strings in the radial direction. This packing allows using the patterns of vortices interaction formed at the packing elements along the flow and across it to intensify the ongoing processes. Advantages of such devices are: simplicity of design, high rates of heat and mass transfer, low power consumption, and ability to treating contaminated gas and liquid flows.

A characteristic feature of apparatuses with a preformed packing is their versatility. Having all the advantages of devices with movable packing, such as a simple design, a low pressure drop and a high efficiency, the apparatuses with a regular plate, tubular and spherical packing equally well be applied in absorption, distillation, condensation, contact cooling of gas and dust collection. The main application these devices finds in chemical engineering and processing, where large amounts of gas emissions and gas treatment processes require a large number of transfer units.

The aim of the work is to study the hydrodynamic characteristics of apparatuses with a regular movable packing of cylindrical, lamellar and ball shapes, for obtaining the dependences for calculating the coefficients of hydraulic resistance, the number of retained fluid.

Nomenclature

ΔP_L	hydraulic resistance, Pa;
W_G	gas rate, m/s;
L	irrigation densities, $m^3/m^2 \cdot h$;
t_v	vertical spacing between elements of packing;
t_r	radial spacing between elements of packing;
b	the size of the square plate packing, m;
d_b	diameter ball packing, m;
d_c	diameter of the cylindrical packing, m;
h_0	dependence of fluid retention, m;
H	packed height, m;
ρ_g	gas density, kg/m3;
ξ_L	coefficient of resistance taking account for the loss of pressure at the interaction of the vortexes in the vertical and radial directions, the gas friction on the surface of the packing cells and the film liquid;
ε_0	porosity of some packing;
Re_L	Reynolds number;
$U_L = L/3600$	velocity of the liquid, m/s;
v_l	coefficient of kinematic viscosity of the liquid, m2/s;
d_{equ}	equivalent diameter of the packing, м;
θ_b	coefficient characterizing the interaction of the vortices in the vertical direction;
θ_r	coefficient characterizing the interaction of the vortices in the radial direction;
$S\lambda$	Strouhal number;
m_k	parameter accounting for vortex formation, streamlined form elements and decrease of vortex rate;

2. Theory

It is known [7] that the flow of solid bodies by gas flow (liquid) is accompanied by the formation and propagation of vortices. For spherical bodies, the arisen and broken down torroidal vortices are symmetrical. For prismatic bodies (cylinders, plates), the vortices appear alternately on one side of the body, then on the other, and their disruption occurs asymmetrically. By installing the streamlined bodies as elements packed in mass transfer apparatuses it can be achieved such an arrangement of elements in the vertical direction of the packing that the time when the vortices