POWER LAW CORRELATION MODELS FOR THE WHOLE DATA BASE

MODEL 1.1: Power Law Correlations

- If $\frac{\mathrm{Re}_{SL}}{\lambda_L} \leq 500$ then:

$$f_M = 13.9796\left(\frac{\mathrm{Re}_{SL}}{\lambda_L}\right)^{-0.9501} \quad (1)$$

Points	Ave. relative error [%]	Standard deviation [%]	Min. relative error [%]	Max. relative error [%]
135	11.01	7.77	0.02	34.88

- If $\frac{\mathrm{Re}_{SL}}{\lambda_L} > 500$ then:

$$f_M = 0.0925\left(\frac{\mathrm{Re}_{SL}}{\lambda_L}\right)^{-0.2534} \quad (2)$$

Points	Ave. relative error [%]	Standard deviation [%]	Min. relative error [%]	Max. relative error [%]
1966	21.10	25.54	0.01	184.21

The 2101 points include all transitions. The equations for each region are shown one in the Figure 1

MODEL1.2: Logistic dose response curve for whole region and all flow patterns

$$f_M = F_2 + \frac{(F_1 - F_2)}{\left(1+\left(\frac{\mathrm{Re}_{SL}}{293\lambda_L}\right)^{4.8638}\right)^{0.1972}} \quad (3)$$

Where F_1 y F_2 are defined as:

$$F_1 = 13.9796\left(\frac{\mathrm{Re}_{SL}}{\lambda_L}\right)^{-0.9501} \quad (4) \qquad F_2 = 0.0925\left(\frac{\mathrm{Re}_{SL}}{\lambda_L}\right)^{-0.2534} \quad (5)$$

Points	Ave. relative error [%]	Standard deviation [%]	Min. Relative error [%]	Max. relative error [%]
2060	20.27	20.78	0.003	183.954

Figure 2 shows the logistic dose response curve for whole region.

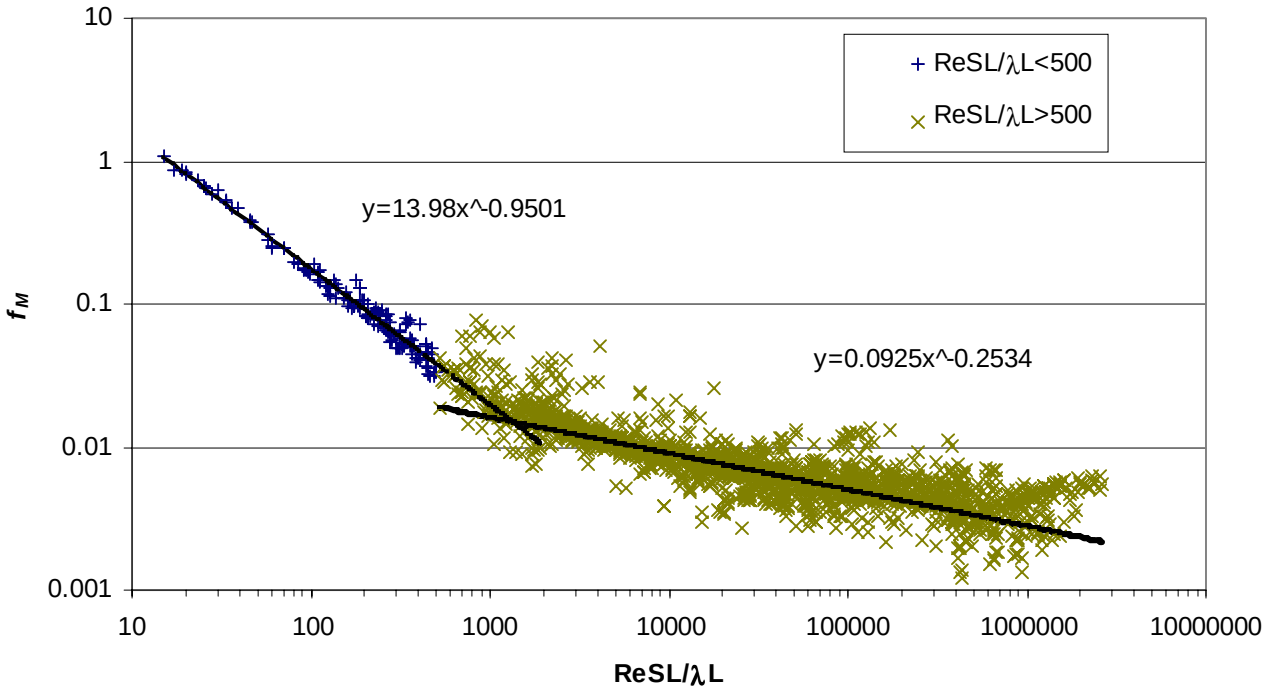

Figure 1.- Power law correlations for ReSL/λL>500 and ReSL/λL<500

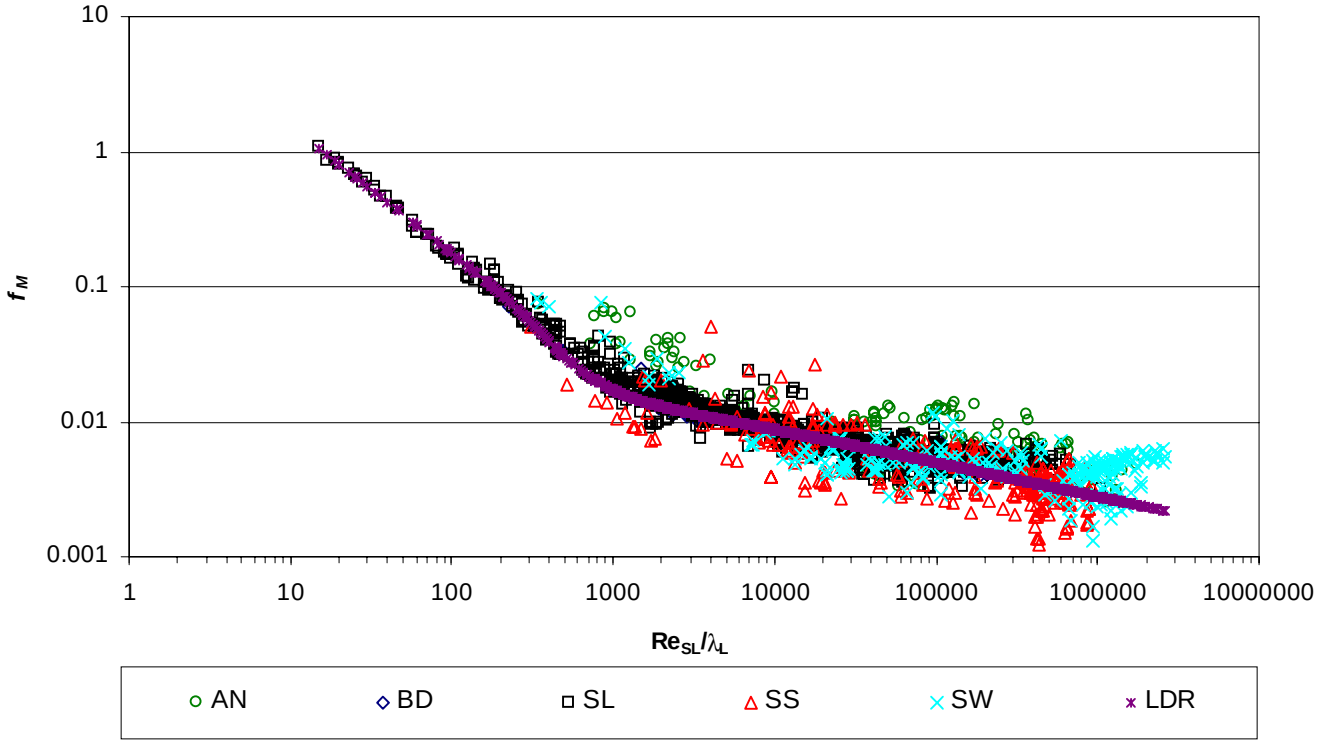

Figure 2.- Logistic dose response curve for the whole region

MODEL 1.3 Logistic dose response curves for segregated and not segregated flow for the whole region

a) Logistic dose response curve for not segregated flow (slug and dispersed bubbles flow)

$$f_M = F_2 + \frac{(F_1 - F_2)}{\left(1 + \left(\frac{\mathrm{Re}_{SL}}{293\lambda_L}\right)^{3.614}\right)^{0.201}} \tag{6}$$

Where F_1 y F_2 are defined as:

$$F_1 = 13.9796\left(\frac{\mathrm{Re}_{SL}}{\lambda_L}\right)^{-0.9501} \tag{7}$$

$$F_2 = 0.1067\left(\frac{\mathrm{Re}_{SL}}{\lambda_L}\right)^{-0.2629} \tag{8}$$

Points	Ave. relative error [%]	Standard deviation [%]	Min. Relative error [%]	Max. Relative error [%]
1356	11.99	11.47	0.01	71.749

b) Logistic dose response curve for segregated flow (annular and stratified flow)

$$f_M = F_2 + \frac{(F_1 - F_2)}{\left(1 + \left(\frac{\mathrm{Re}_{SL}}{300\lambda_L}\right)^{11.6984}\right)^{0.0217}} \tag{9}$$

Where F_1 y F_2 are defined as:

$$F_1 = 13.9796\left(\frac{\mathrm{Re}_{SL}}{\lambda_L}\right)^{-0.9501} \tag{10}$$

$$F_2 = 0.0978\left(\frac{\mathrm{Re}_{SL}}{\lambda_L}\right)^{-0.2457} \tag{11}$$

Points	Ave. relative error [%]	Standard deviation [%]	Min. Relative error [%]	Max. relative error [%]
704	33.27	23.15	0.02	180.42

Figures 3 and 4 show the logistic dose response curves for not segregated and segregated flow, respectively.

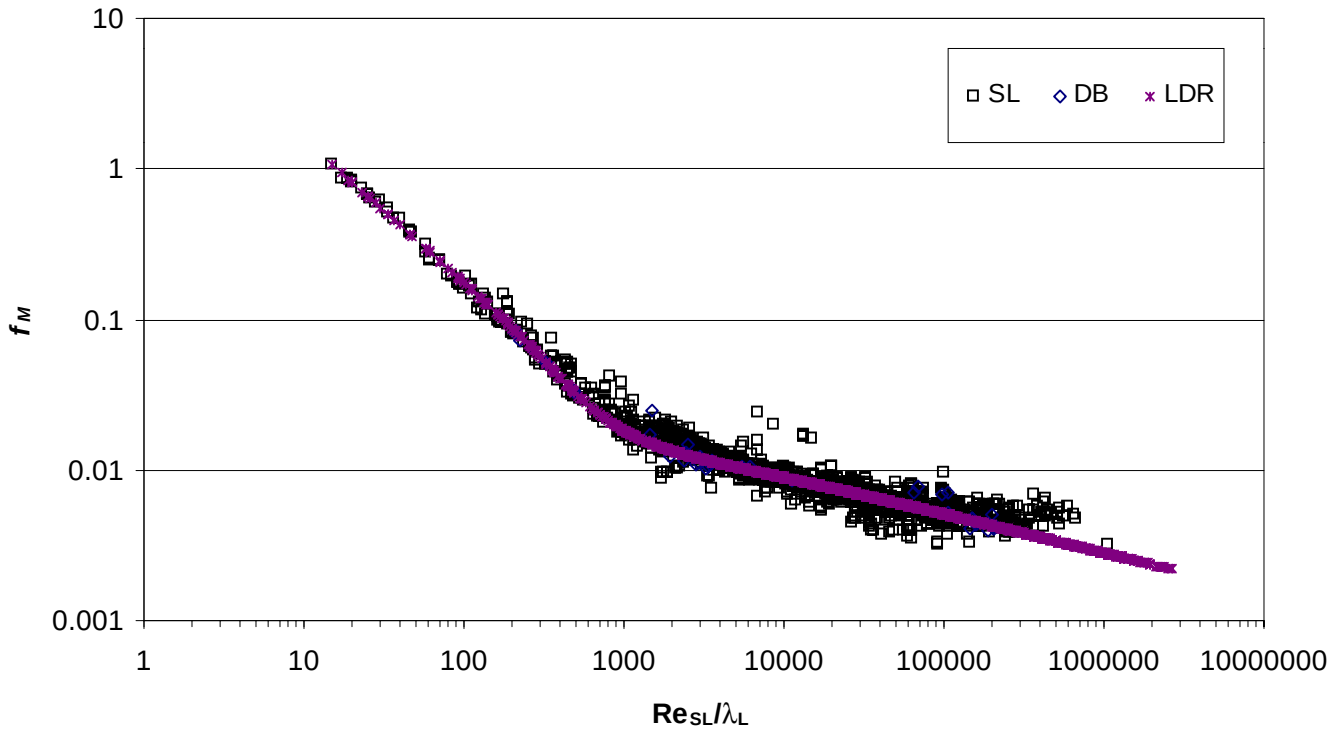

Figure 3.- Logistic dose response curve for not segregated flow

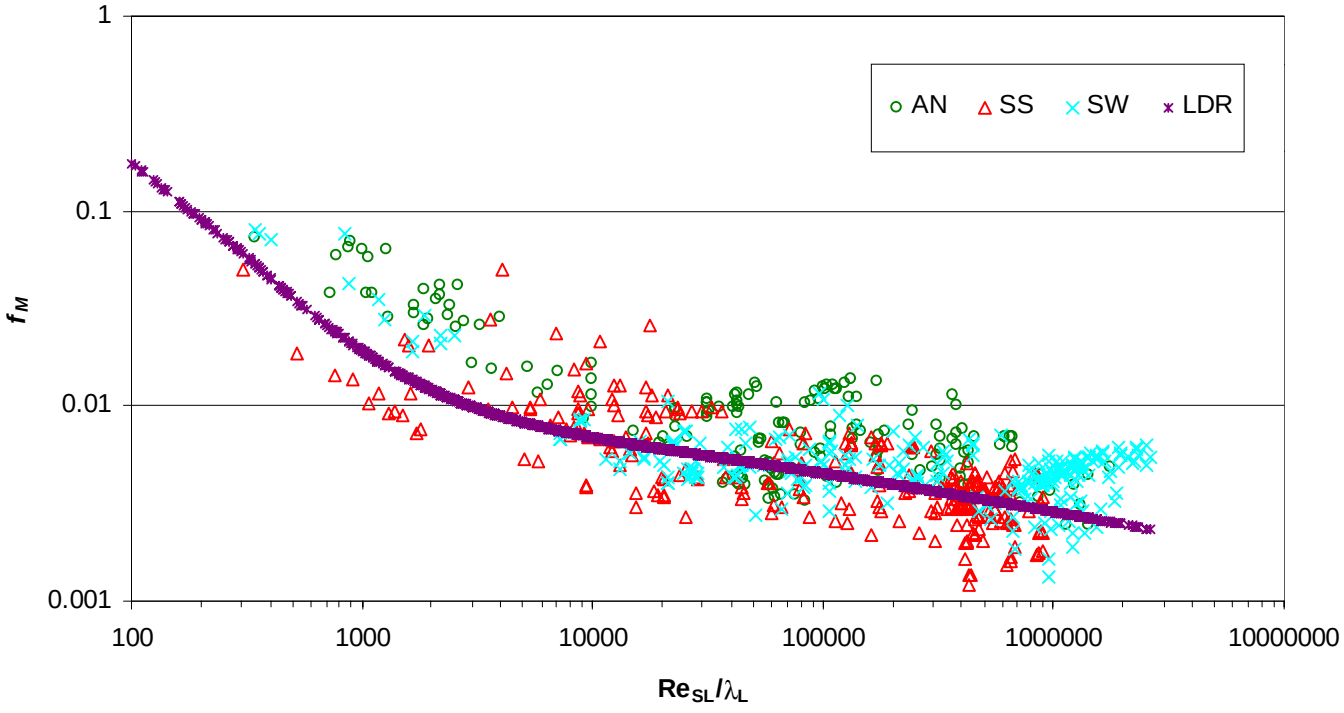

Figure 4.- Logistic dose response curve for segregated flow

MODEL 1.4 Logistic dose response curves for the whole region per flow pattern

a) Logistic dose response curve for slug flow.

$$f_M = F_2 + \frac{(F_1 - F_2)}{\left(1 + \left(\frac{\mathrm{Re}_{SL}}{293\lambda_L}\right)^{3.5678}\right)^{0.2025}} \quad (12)$$

Where F_1 y F_2 are defined as:

$$F_1 = 13.9796\left(\frac{\mathrm{Re}_{SL}}{\lambda_L}\right)^{-0.9501} \quad (13) \qquad F_2 = 0.1076\left(\frac{\mathrm{Re}_{SL}}{\lambda_L}\right)^{-0.2637} \quad (14)$$

Points	Ave. relative error [%]	Standard deviation [%]	Min. Relative error [%]	Max. relative error [%]
1316	11.99	11.46	0.00	71.65

b) Logistic dose response curve for dispersed bubble flow.

$$f_M = F_2 + \frac{(F_1 - F_2)}{\left(1 + \left(\frac{\mathrm{Re}_{SL}}{293\lambda_L}\right)^{3.1935}\right)^{0.1888}} \quad (15)$$

Where F_1 y F_2 are defined as:

$$F_1 = 13.9796\left(\frac{\mathrm{Re}_{SL}}{\lambda_L}\right)^{-0.9501} \quad (16) \qquad F_2 = 0.0866\left(\frac{\mathrm{Re}_{SL}}{\lambda_L}\right)^{-0.2422} \quad (17)$$

Points	Ave. relative error [%]	Standard deviation [%]	Min. Relative error [%]	Max. relative error [%]
40	8.67	9.47	0.03	43.19

Figures 5 and 6 show the logistic dose response curves for slug flow and dispersed bubble flow, respectively.

c) Logistic dose response curve for stratified flow.

$$f_M = F_2 + \frac{(F_1 - F_2)}{\left(1 + \left(\frac{\mathrm{Re}_{SL}}{300\lambda_L}\right)^{9.2749}\right)^{0.0324}} \quad (18)$$

Where F_1 y F_2 are defined as:

$$F_1 = 13.9796\left(\frac{\mathrm{Re}_{SL}}{\lambda_L}\right)^{-0.9501} \quad (19) \qquad F_2 = 0.0445\left(\frac{\mathrm{Re}_{SL}}{\lambda_L}\right)^{-0.1874} \quad (20)$$

Points	Ave. relative error [%]	Standard deviation [%]	Min. Relative error [%]	Max. relative error [%]
528	30.42	23.29	0.00	186.18

d) Logistic dose response curve for annular flow.

$$f_M = F_2 + \frac{(F_1 - F_2)}{\left(1 + \left(\frac{\mathrm{Re}_{SL}}{10000\lambda_L}\right)^{2.1909}\right)^{0.2072}} \quad (21)$$

Where F_1 y F_2 are defined as:

$$F_1 = 3.6709\left(\frac{\mathrm{Re}_{SL}}{\lambda_L}\right)^{-0.6257} \quad (22) \qquad F_2 = 0.027\left(\frac{\mathrm{Re}_{SL}}{\lambda_L}\right)^{-0.1225} \quad (23)$$

Points	Ave. relative error [%]	Standard deviation [%]	Min. Relative error [%]	Max. relative error [%]
176	29.59	17.73	0.00	77.12

Figures 7 and 8 show the logistic dose response curves for stratified flow and annular flow, respectively.

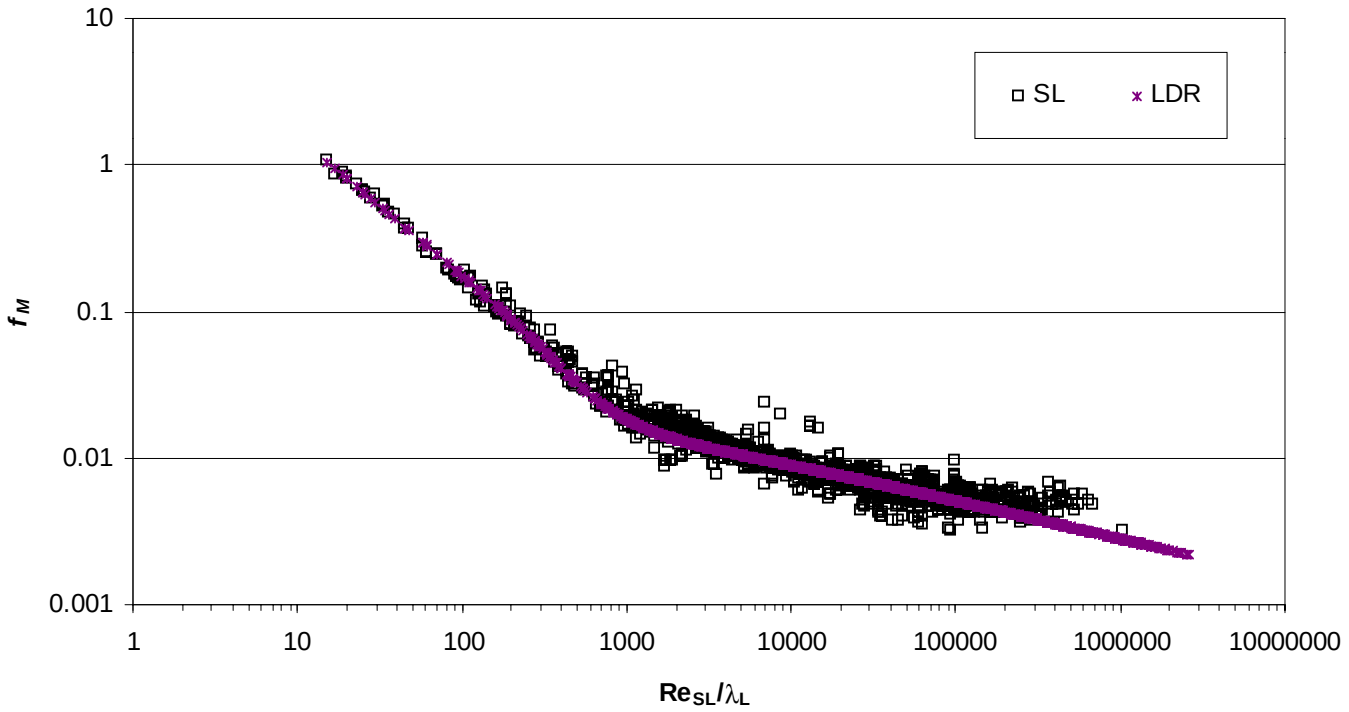

Figure 5.- Logistic dose response curve for slug flow

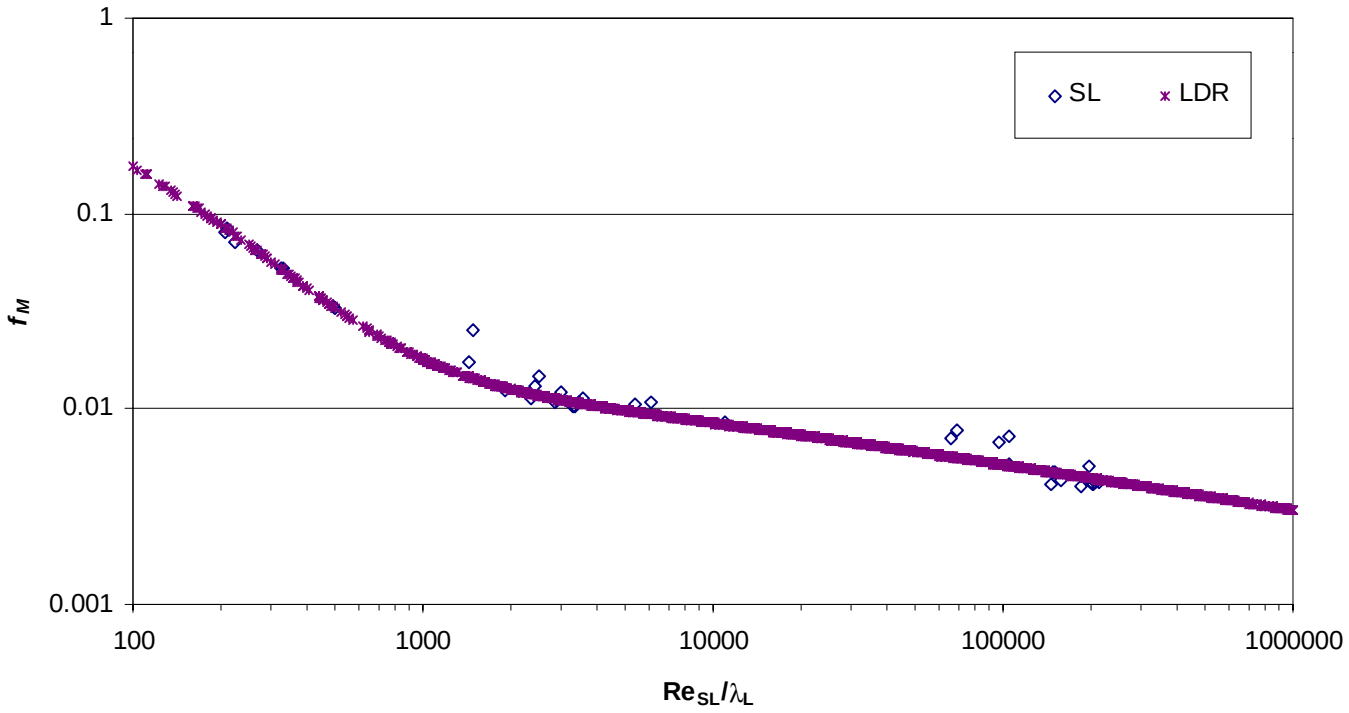

Figure 6.- Logistic dose response curve for dispersed bubble flow

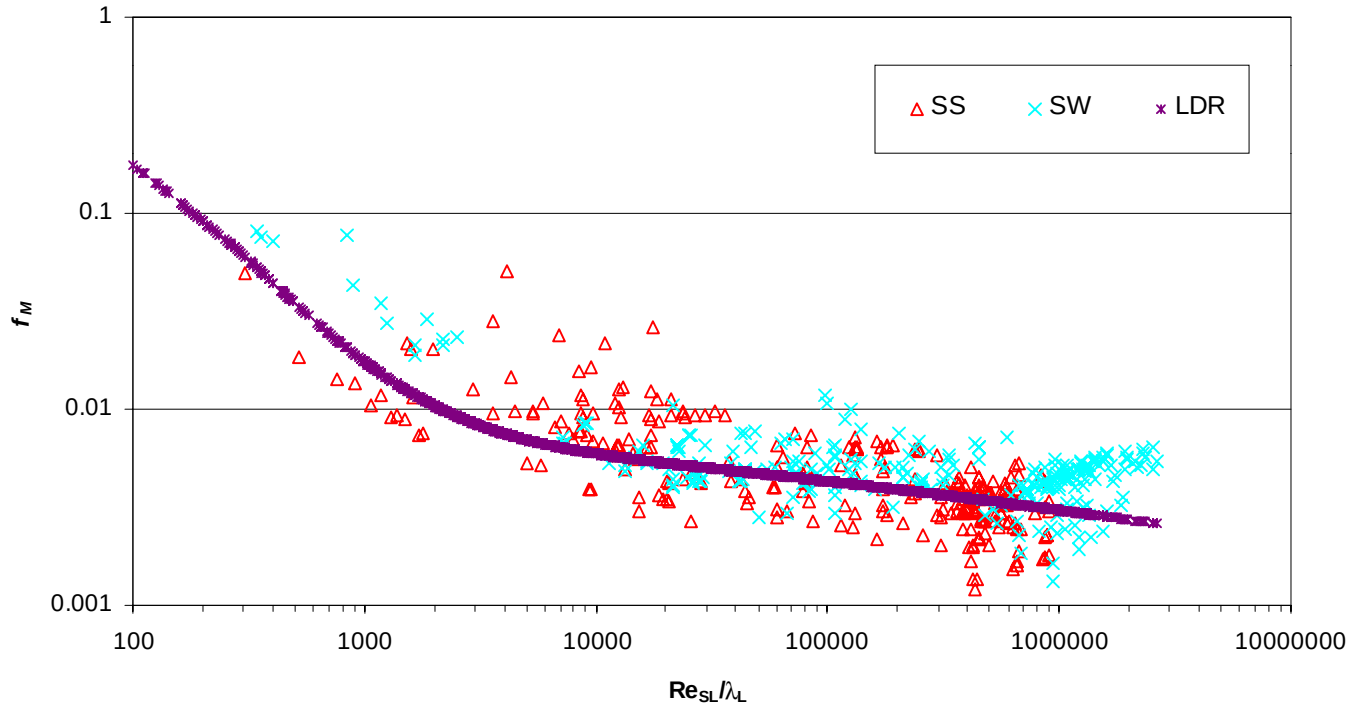

Figure 7.- Logistic dose response curve for stratified flow

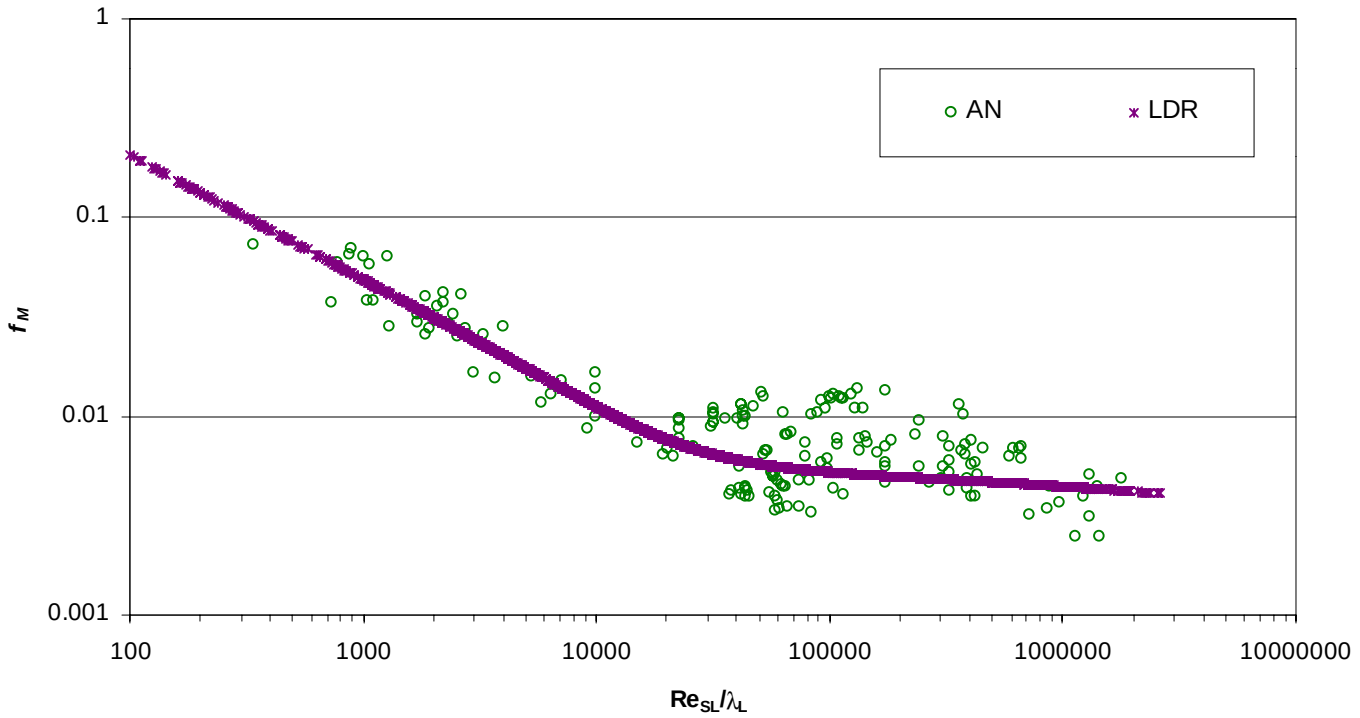

Figure 8.- Logistic dose response curve for annular flow