Evaluation of interference in the changing of measurement geometry in multiphase flows using the MCNP-X code

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This report aims at evaluating the interference in the results of the geometry changes to accurately provide the volume fractions through the evaluation of different geometries (source-detector position and flow regimes) simulations in the MCNP-X code. A NaI(Tl) scintillation detector 1"x1" [2], a source (^{137}Cs) and an acrylic tube was used, as shown in Fig. 1.

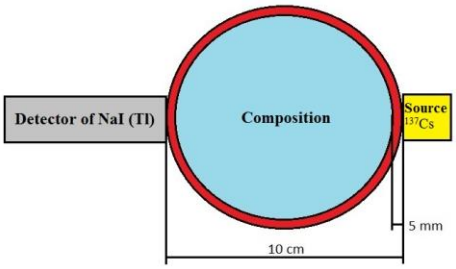

Figure 1. Model of geometry used in the simulations.

The study was performed for the annular and smooth stratified flow regimes. Two types of biphasic compositions are used: one with 50% water and 50% oil (0.896 g.cm^{-3} density) and the other one with 50% air and 50% oil [1]. In the smooth stratified flow regime, the position of the source in relation to the detector was changed while in the annular regime it was the position of the material inside the pipe that was changed. Studies with two hypothetical homogeneous compositions with the same percentage of the compositions previously used (50% of each material) was also carried out in order to evaluate if the homogeneity of the compositions affects the results. These studies were also simulated with two different types of beam: a divergent and a pencil beam. Based on the simulations, the total areas of the spectra and the percentage differences were calculated. It can be concluded that the change of the source-detector position in the smooth stratified regime does not influence the results of studies. However, when the position of the material in the annular regime is changed, there is interference in the results, and, with reference to the densities studied, its influence increases as the difference between the densities increases too, as shown in Table 1.

Table 1. Percentage differences to the exchange of source-detector and material position.

Flow Regime	Type of beam	50% oil + 50% water	50% air + 50% oil
Smooth Stratified	Divergent	3%	10%
	Pencil	2%	7%
Annular	Divergent	12%	43%
	Pencil	12%	43%

Table 2. Percentage differences between homogeneous and each biphasic composition.

	Regime Smooth Stratified				Regime Annular			
	A[1]	B[2]	C[3]	D[4]	A	B	C	D
Composição Homogenea	7%	5%	17%	5%	11%	1%	46%	16%

1 - Geometry Detector-oil-water-source
2 - Geometry Detector-water-oil-source
3 - Geometry Detector-oil-air-source
4 - Geometry Detector-air-oil-source

The results of the variations between homogeneous and heterogeneous compositions, shown in Table 2, indicate that there is no interference in the results when similar densities are used and indicates a possible influence in the study where the difference between the densities is bigger. The change of the kind of collimation of the source, does not influence the result of the study, however, it improves the counting statistics, providing greater accuracy of the data collected. Using the technique developed it is possible to identify the flow regime of a two-phase flow through the spectra. Results show that the geometry which presents less influence is the one with a smooth stratified regime. In order to develop new procedures, studies to analyse different material volume fractions are being carried out and a static experimental setup is being done to validate these works.

References

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