Collaborative Research on Fluidization
Employing Computer-Aided Particle Tracking

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by

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Introduction

This report covers the sixth quarter of the subject contract. The primary objective of this quarter was modifying the software and testing the hardware of the transportable computer-aided particle tracking apparatus to be used at the Morgantown Energy Technology Center. While the data acquisition programs have been described in the last report, the program names were changed and the method for input to these programs was modified for convenient use. The hardware settings and arrangement were checked in order to obtain the optimum operating condition.

Discussions

I. Modification of Software

The data acquisition software for the particle tracking facility composes of four programs as described in the previous report: RAWCAL, PD, MAIN, and PROCESS. These programs have been renamed as RAWCAL, POLYFIT, COUNTS, and POSITION, respectively. Program RAWCAL takes the raw calibration data. Program POLYFIT uses polynomial fit of the raw calibration data to create calibration tables. Program COUNTS runs the actual data acquisition and stores the counts data on the hard disk. Program POSITION calculates the tracer positions from the counts data using the calibration tables and stores the position data on the hard disk.

In the previous version of the software the data input for the programs should be typed in at the same time as a particular program was run. This process is not only easy to cause errors but also inconvenient. In the new version, all input data are stored in a document file, TEST.TXT, as listed in Fig. 1. Other test information, including the tracer identification, the bed operating conditions, and the detector arrangement, may be filled following the first seven lines in the file. The essential data in TEST.TXT are three data file names: the test name (e.g., TSTM20), the raw data file name (e.g., RAWM20), and the calibration table file name (e.g., CALM20), and two parameters controlling the data acquisition: the sampling rate (in msec) which represents a period in which a tracer position is determined, and the test length (in kilobytes) which specifies the total amount of count data to be stored on the hard disk. These five inputs should appear after the ">" prompts at the corresponding lines as shown in Fig. 1. The data acquisition programs read the information from TEST.TXT when they are run. Specifically, program RAWCAL stores its data in the raw data file with an extension .DAT (e.g., RAWM20.DAT); program POLYFIT reads the raw data and generates the calibration tables to be listed in the table file with an extension .TBL (e.g., CALM20.TBL); program COUNTS puts all the count data from an experiment into a (binary) data file having the test name and an extension .OUT (e.g., TSTM20.OUT); program POSITION reads the calibration tables and the count data and presents the tracer positions into a (binary) data file having the test name

and an extension .DAT (e.g., TSTM20.DAT). However, for the subsequent calculations for the mean solids motion and other statistical quantities only the position data are needed.

By creating the document file TEST.TXT, the interconnection between the data acquisition programs is automatically fixed. This will eliminate a potential source of error as one does not have to remember the program input information during an experiment.

II. Hardware Settings

The practical consideration for setting up the hardware of the particle tracking facility is that while the true counts are recorded the noise signal must be eliminated. Figure 2 shows the typical spectrogram for SC-46 used in the tracer particle. The two intensity peaks at high energy levels 0.889 MeV and 1.112 MeV are generated from the gamma photons emitted directly from Sc-46, but the lower energy readings are from the secondary gamma radiation. With this source of gamma radiation, the detector will generate electrical pulse signals with higher peaks by the high energy photons and lower peaks by the lower energy secondary emissions. When the detector output is fed into a discriminator, the lower peak noise pulses may be effectively eliminated by adjusting the threshold while the true signals will go through to be counted. Therefore, both the detector output and the threshold need to be adjusted.

The power supply for the detectors has been determined to be 1500 V. With this high voltage, all the 16 detectors may be adjusted to generate output signals at 40 mV from the reading of a Tektronix

2235 Oscilloscope (Tektronix, Inc., Beaverton, Oregon). However, since the input resistance of the oscilloscope is the same as the detector output resistance ($1\text{ M}\Omega$), the true signal height can not be determined. This can be demonstrated by measuring the count rate at various threshold settings as shown in Fig. 3. It is seen that the true signals should be at about 90 mV. Between 70 mV and 80 mV there is a sharp decrease of the count rates. This is probably due to the signals generated by the 0.889 MeV photons being cut off at that threshold range. From Fig. 3 we may set the threshold at 60 mV.

III. Consideration for Detector Arrangement

The detector count rate is approximately proportional to the inverse square of the distance between the detector and the point radioactive source. The relative error of the rate fluctuation from the mean due to the statistical nature of radiation is smaller when the count rate is large. Therefore, the detectors should always be arranged as close to the bed as possible. But when the detector and the source is too close, the detector output pulses may pile up (or saturate) and lead to a decrease of the count rate. Figure 4 shows a typical behavior between the count rate and the distance, here the distance is measured from the detector crystal center (the center is on the detector axis and at 1 inch from the detector front surface) and the point radioactive source. It is seen that the saturation starts when the distance is about 135 mm, and then the count rate decreases rapidly. This suggests that the minimum distance

should be 135 mm between the detector centers and the inside wall of the bed column (or 110 mm (4.3 in) between the front surfaces of the detectors and the inside wall of the bed) in order that the detectors function properly.

Test name	>tstm20	By:	Date:
RAWCAL.EXE output	>rawm20	(raw data)	
POLYFIT.EXE output	>calm20	(calibration table)	
Test Length	>2	kilobytes	
Sampling Rate	>20	msec	

Figure 1 List of Document File TEST.TXT

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Figure 2 Typical Spectrogram for SC-46

Figure 3 Change of Count Rate with Threshold Setting

Figure 4 Change of Count Rate with the Distance between Detector Center and Point Radioactive Source

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