

VERSION [1.1]
JANUARY 15, 2013



AUTO-DILUTION PARTICLE COUNTER

CINRG CS-APC-2 WHITE PAPER

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AUTO-DILUTION PARTICLE COUNTER

INTRODUCTION

The CINRG CS-APC-2 particle counting system is a fully automated system that meets the requirements of ASTM D7647-10 in which oil samples are diluted with solvent prior to testing in order to eliminate interferences from "soft" particles such as water, varnish and suspended liquid additives.

The system combines equipment from several leading equipment manufacturers with some innovative technology and sophisticated software that was developed by Wearcheck Canada Inc for use in their oil Analysis laboratory. The system has a high degree of flexibility and can be customized to a large extent to suit local laboratory processing requirements.

CINRG CS-APC-2 FULLY AUTOMATIC AUTO-DILUTING PARTICLE COUNTER



SAMPLE BATCH PREPARATION

A batch of samples can be quickly prepared by pouring suitable volumes of homogenized sample into 2oz (32ml) sample cups that are then placed in a 104 position sample tray. Samples do not have to be accurately dispensed into the sample cups as the volume of the sample in each cup is measured by the system to an accuracy of $\pm 2\%$ prior to dilution. Laboratory technicians can easily control sample dilution by controlling the amount of sample that is poured into the cup as all samples are diluted to a final volume of 30ml.

If a higher degree of accuracy than $\pm 2\%$ is desired for the volume measurement samples may be pipetted or weighed into the cups and the sample volume or sample weight and sample density included in the systems batch file. Team goals

SAMPLE VISCOSITY RANGE

As samples are diluted prior to testing and dilution ratios can be varied between 1:0 (no dilution) and 1:9 (one part oil and 9 part solvent) it is possible to process samples having a wide range in viscosities. A 1:4 dilution for example, is more than adequate to process an oil sample with a viscosity of 1,000 cSt @ 40°C.

Samples can be processed without dilution if required but viscosity of these samples should be ≤ 46 cSt.

BATCH FILE

A batch file containing both sample information and processing parameters is required by the application software in order to process samples and this can be created within the software itself or imported from an external file in csv format. The sample information part of the batch file contains the sample ID, the sample position within the tray and if applicable, a sample volume or sample weight and density. If the sample volume and weight fields are blank the system will measure the volume of oil in the sample cup prior to sample dilution.

The process parameters control how the sample is processed prior to testing. The parameter settings determine how fast and for how long a sample is stirred and determine how a sample is degassed if this process is required. The report format can also be specified in the batch file (ISO 4406 or AS4059).

The parameters are typically in the range of 1 to 4 with the actual value of each setting being determined by system parameters that can be modified by the end user. E.g. Sample stirring times of 1, 2 and 3 in the batch file could be defined as 15, 20 and 30 seconds in the system parameters.

SOLVENT VERIFICATION

Before any testing is conducted the cleanliness of the batch of dilution solvent has to be determined to obtain the count data that is subsequently used to correct the particle count results for the effects of dilution. When selected in the application software a solvent verification is carried out automatically. Solvent is initially loaded into the sample cup in position 1 for use as a system flush and then into the sample cup in position 2 for actual measurement. Several measurements are conducted on the solvent and the suitability of the solvent is established by comparing the counts from each measurement against a set of system parameters that again can be modified by the end user to meet specific needs.

When sufficient data has been collected average count values are calculated from valid measurements and stored as the solvent background counts for subsequent calculations.

SAMPLE PROCESSING

Samples are prepared and tested in the following manner:

- Sample volume is determined by the system if no sample volume or weight data is in the batch file
- Sample is diluted with solvent to yield a final volume of 30ml of diluted sample. If the cup has been completely filled with sample the system will process the sample undiluted.
- Sample is stirred to dissolve the oil in the solvent and to uniformly suspend particulates in the solution. Sample stirring speed and time are determined from batch file entries and the corresponding system parameters.
- While the sample is still being stirred a small volume of sample is aspirated into the sampling syringe and dispensed through the sensor to displace solvent from the previous cleaning process.
- The stirrer is stopped and sample syringe is immediately filled with sufficient sample to conduct three separate measurements.
- If required sample degassing is implemented whereby a vacuum is created and then released within the sample syringe itself. Again the degassing process is defined by entries in the batch file and the corresponding system parameters.
- After testing, count data is corrected for the solvent background and a result file output to a results directory after the raw count data has been check for conformance to ASTM D7647 requirements. Result files for samples having count data that fails ASTM requirements are saved in a dedicated directory for investigation purposes.
- After completion of a measurement the system implements a cleaning cycle in which the system is flushed with several small volumes of solvent. The number of flushes utilized is dependent on the cleanliness of the sample that is being flushed from the system. System parameters allow the user to define four levels of counts at which additional flushes are implemented as well as the number of additional flushes implemented at each level.
- If required the system will measure the solvent to confirm system cleanliness before processing to the next sample.

URGENT SAMPLES

The sample batch file remains accessible even after processing has started and may be edited at any time to add to or remove samples from a batch or to set a priority flag within the batch to allow a sample to be processed out of sequence.

It is not possible to edit samples that have already been processed or edit the sample that is in process at the time of editing.

PROCESS CONTROL SAMPLES

Process control samples must be identified with a three letter suffix to be treated as such. The default suffix is "PCS" but this is a system parameter and can be changed by the end user. The count data obtained for these samples is compared against upper and lower user defined limits in the 4µm, 6µm and 14µm range to confirm acceptable system performance.

A system parameter is used to control how the system proceeds following an unsatisfactory result on a process control standard. The parameter can be set to either abort the process or proceed with an additional check on the next process control sample.

REPORTING

The sample batch file contains a report field that is used to set the report format of the final results in the output file (ISO 4406 or AS4059). There are also a number of system parameters that can enable or disable the inclusion of additional information in this file.

With the system parameters it is possible to include such information as solvent background counts, sample volume, sample dilution ratio, and all raw count data in the output file.

SYSTEM INFORMATION

SYSTEM PERFORMANCE

Parameter	Specification
Sample Through-put	4.5 min/sample (7-3/4 hrs for complete 102 sample tray)*
Solvent Usage	40 ml/sample**
Sample Batch Size	102 samples (tray has 104 positions, pos 1 = cleaning beaker, pos 2 = verification solvent)

* Sample through-put rate is directly dependent on the settings of the processing parameters. Specification stated is using default parameters.

** Solvent usage depends directly upon the dilution ratios and processing parameters. Specification stated is for 1:1 dilution using the default parameters.

PARTICLE SENSOR

Parameter	Specification
Model	KLOTZ LDS 45/50 Laser Sensor
Measuring Range	1.5µm to 100µm
4µm co-incidence threshold	25,000 particles/ml (undiluted sample) 50,000 particles/ml (1:1 dilution)
Cell Dimensions	450µm x 450µm
Flow Rate	10 to 50 ml/min (CS-APC-2 instrument is calibrated at 30 ml/min)

PARTICLE COUNTER

Parameter	Specification
Model	KLOTZ USB Counter
Count Mode	4,096 channels

SAMPLE LEVEL SENSOR

Parameter	Specification
Model	Baumer UNKC 09
Accuracy	±0.1 mm from 3mm to 150mm

PHYSICAL SPECIFICATIONS

Parameter	Specification
Dimensions	36" (W) x 30" (H) x 31" (D) (91cm x 76cm x 79cm)
Weight	85 lbs (39 kg)
Voltage Requirement	100-120-230/240VAC selectable, 50/60 Hz.
Input Current	6.0A @100V, 5.0A @ 120V, 2.6A @ 230V, 2.5A @ 240V