FEATURES IN THIS BULLETIN

- Significence of the method
- Procedure
- Reporting the results

Beckman Coulter Application Bulletin

Beer, Evaluation of Final Product and Filtration Efficiency

Multisizer™ 3 COULTER COUNTER®

The concentration and size distribution of particles in beer may be measured using the Coulter Principle also known as the Electrical Sensing Zone (ESZ) method. A suitable electrolyte solution is required to perform the analysis. The sample is prepared by dissolving a certain volume of beer in the electrolyte and then analyzed using a Beckman Coulter Multisizer 3 to determine the size distribution and concentration for the particles present in the beer. The results are reported as number of particles per milliliter for the desired size range.

The use of the Multisizer 3 provides a fast, easy, accurate and automatic method to determine the particle content in beer. The use of this instrument also provides reliable results not dependent on the operator's judgment making it possible to compare data from different work shifts and/or breweries.

BECKMAN COULTER™

EVALUATION OF BEER FINAL PRODUCT AND FILTERATION EFFICIENCY

SIGNIFICANCE

The determination of particle concentration in beers is important for evaluating and/or correcting several steps during the brewing process and finishing of the product.

- **Evaluation of the Final Product.** Each kind of beer has its own characteristics and distinctive flavor; these properties will be influenced to some extent by the content and size distribution of particles present in the final product. The stability and therefore the shelf life of beer are also affected by its particle content.
- **Evaluation of Chill Haze Effect.** This is the most common, and in some sense, the most important type of beer hazesince it is relevant to many beer types. As the name suggests, this haze appears when the beer is suitably chilled; the haze disappears upon warming. The temperatures at which the haze appears and disappears depend on the physical stability of the beer. The more stable the beer, the closer to 0 °C before chill haze occurs. The haze involves complexes of highmolecularweight proteins and polyphenols (tannins). These compounds form weak, temperature sensitive hydrogen bonds that are broken as the beer's temperature increases, allowing the resulting compounds to form a complex with water molecules and go into solution.
- **Filtration Efficiency.** Brewers have been using some type of filtration for centuries. If properly used, it can serve as an effective nonadditive tool in beer clarification. Filtration is used in conjunction with fining agents to render beer brilliantly clear and stable with respect to temperature changes.

In this paper we will refer to the evaluation of the final product and filtration efficiency.

EVALUATION OF FINAL PRODUCT INSTRUMENT SET UP AND CALIBRATION

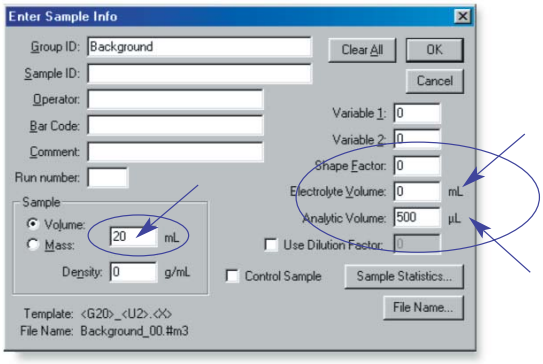
A 50 µm aperture tube is used for the evaluation of the final product. The linear dynamic range for any aperture is 2% to 60% of its size, i.e. a 50 µm aperture tube will be capable of analyze the particle concentration and size distribution from 1 µm to 30 µm. Set up and calibrate the instrument according to the Multisizer 3 Operator's Manual. For determining particle concentration the control mode for the instrument must be Volumetric Mode, select 500 µL.

PROCEDURE

1. *Running a Background*

Entering background information in the Multisizer 3 Software. By entering the background information, the software will be able to calculate the concentration of particles in the Isoton.

- Sample Volume: 20 mL
- Electrolyte Volume: 0
- Analytical Volume 500µL



1.1 Place 20 mL of Isoton® II in an Accuvette® II.

1.2 Place into the analyzer the Accuvette® II containing the Isoton, flush the aperture tube before the run.

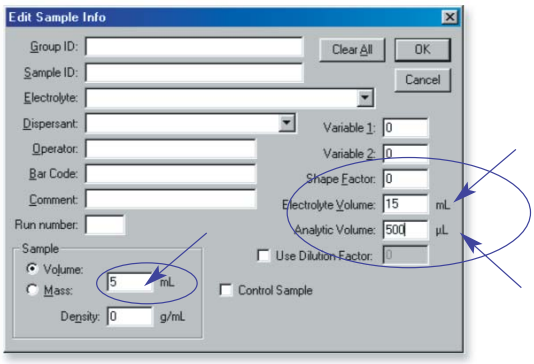
1.3 On the Multisizer software set the background. The background will be automatically subtracted from all subsequent analyses until a new background is set.

2. *Analyzing the Sample*

2.1 Entering sample information in the Multisizer 3 Software.

Enter the required sample information in the software: analytical volume electrolyte (Isoton) volume and volume of beer used for the analysis. By entering the sample information, the software will be able to calculate the concentration of particles in the beer.

- Sample Volume: Enter the amount of sample to be use in the analysis
- Electrolyte Volume: Enter the amount of Isoton to be use in the analysis
- Analytical Volume 500 µL



2.2 *Sample preparation*

After removing gas from the beer, measure exactly 15 mL of Isoton® II into a 20 mL Accuvette® II. Pipette 5.0 mL of beer into the Isoton, these quantities may be different according to the kind of beer, for example for Wheat Ales a smaller amount of sample and more Isoton will be needed. Cap the Accuvette and stir gently to dissolve thoroughly without creating bubbles. Prepare each sample at the moment it will be analyzed.

2.3 Place into the analyzer the Accuvette® II containing the sample, flush the aperture tube before the analysis.

2.4 After each run rinse the aperture and electrode before proceeding to the next sample.

3. *Reporting the Results*

Results are reported as the total number of particles per mL from 1 to 30 µm and /or particles per mL larger than 1, 2, 3, 4, 5, 10, 15 and 20 µm.

	Particles / mL Larger than							
	1 µm	2 µm	3 µm	4 µm	5 µm	10 µm	15 µm	20 µm
BECK'S	10,213	2,493	1,012	538	281	88	51	7
BUDWEISER	16,950	1,776	697	426	341	183	110	44
COORS LIGHT	11,731	1,702	586	273	154	38	16	0
CORONA EXTRA	3,601	751	377	231	147	59	29	11
FULLER'S LONDON PRIDE	744,862	107,715	35,884	16,347	8,423	693	118	24
GRANT'S IPA	330,673	58,915	15,908	5,800	2,655	205	48	9
HEINEKEN	81,292	13,888	5,302	2,968	2,071	877	354	76
MILLER LITE	3,144	747	378	298	217	76	45	14
MILLER MGD	12,638	1,845	456	181	110	22	4	0
PRESIDENTE	29,508	5,801	2,332	1,177	615	124	62	23
SAMUEL ADAMS	352,452	80,701	27,613	12,089	6,204	700	133	32
SAM. ADAMS WINTER LAGER	87,196	12,763	4,501	2,048	961	69	7	0
SINGHA	99,980	24,166	9,879	4,857	2,678	255	37	12
THE KNIGHT'S ALE (WHITE ALE)	15.36×10^6	1.545×10^6	1.368×10^6	1.278×10^6	661,568	1,654	306	79

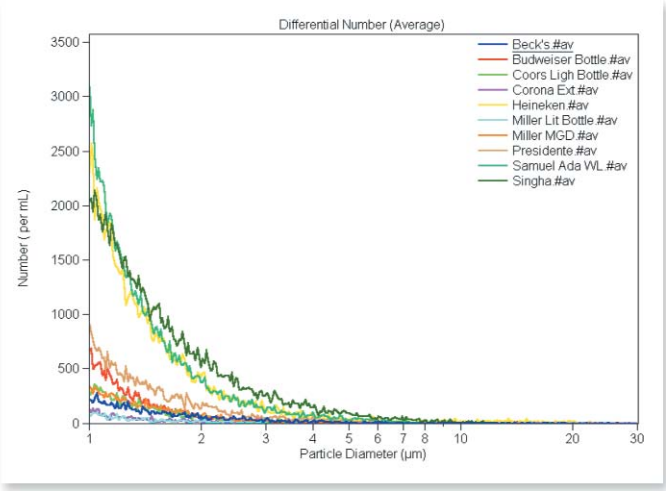
EVALUATION OF BEER FINAL PRODUCT AND FILTERATION EFFICIENCY

	Particles/ml 1-30 µm)		Particles/ml 1-30 µm)
Beck's (Germany)	10,213	Miller Lite (USA)	3,144
Budweiser (USA)	16,950	Miller MGD (USA)	12,638
Coors Light (USA)	11,731	Presidente (Dominican Republic)	29,508
Corona Extra (Mexico)	3,601	Samuel Adams (USA)	352,452
Fuller's London Pride (UK)	744,862	Sam. Adams Winter Lager (USA)	87,196
Grant's IPA (USA)	330,673	Singha (Thailand)	99,980
Heineken (Holland)	81,292	The Knight's Ale (Belgium White Ale)	15.36×10^6

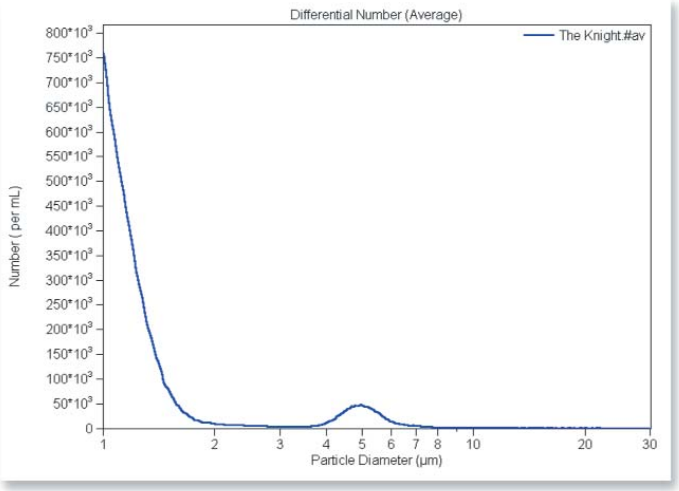
The above data does not represent by any means a comparison for different brands of beer. The samples were randomly selected from brands and kinds of beers available at the market, therefore they have different characteristics and they have been manufactured at different dates and stored under diverse conditions and length of time. The only purpose of this table and following graphs is to show how the results are reported.

DETERMINATION OF SIZE AND CONCENTRATION OF PARTICLES IN BEER FINAL PRODUCT

Comparison Graph for Different Kinds of Beer



Belgian Wheat Ale



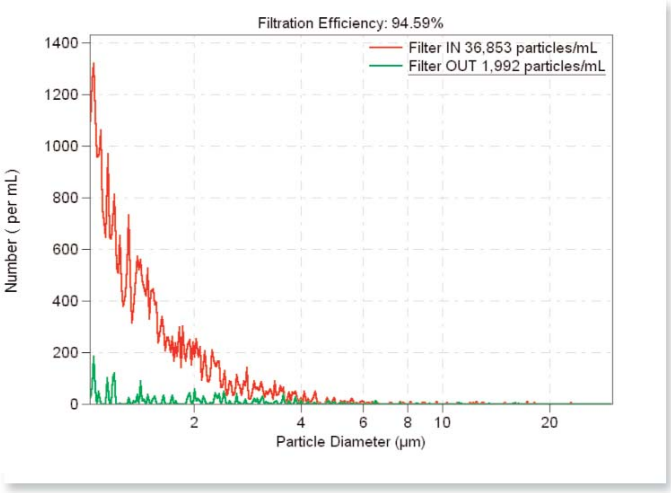
EVALUATION OF BEER FINAL PRODUCT AND FILTERATION EFFICIENCY

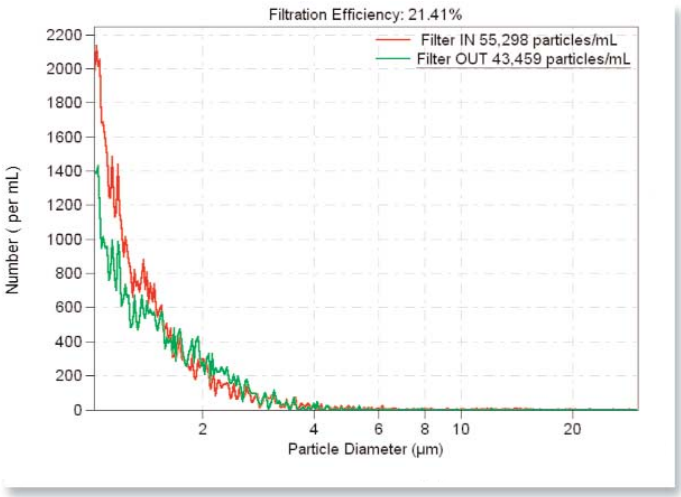
FILTRATION EFFICIENCY

Set up the instrument and follow the same procedure described for the final product steps 1 through 2.4. Perform the analysis for beer getting into the filter and coming out from the filter.

REPORTING THE RESULTS

The efficiency of the filter is determined by comparing the results before and after filtration. The amount of particles removed as a percentage of the particles present before the filtration gives the percentage of efficiency.





EVALUATION OF BEER FINAL PRODUCT AND FILTERATION EFFICIENCY

The filtration process may also be monitored for specific size ranges. The total number of particles removed not always provide a complete picture of a filtration deficiency, sometimes it is necessary to target certain size range for adjusting the filtration process.

Particle Diameter (µm)	Filter IN Number per mL larger than	Filter OUT Number per mL larger than	Efficiency (%)
1	35,296	1,875	94.68
2	5,427	744	86.29
3	1,560	327	79.02
4	498	135	72.95
5	244	77	68.30
10	56	19	66.66
15	22	8	63.61
20	4	0	100