Non-destructive segment size measurement for complex Tobacco Heating Products

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Introduction

Tobacco heating product (THP) constructions are becoming increasingly complex and tools for quality assurance of these products are not yet readily available.

X-ray systems are known to have been used in laboratory situations to assist in product development but have suffered from the complexity available of the systems and the high capital outlay. Translating such capability to a routine quality assurance tool that can be sited close to a combiner and form part of the routine quality check of production is a complex engineering challenge.

A system has been devised that can be fitted into an existing physical test station – the Cerulean Quantum Neo – and used to routinely measure hidden segment length and diameters.

Quantum Neo x-ray shelf

The design of the shelf is fully integrated into the hardware and software of the Quantum Neo product. The system consists of a fully shielded enclosed system with fail safe interlocks that prevent the operator being exposed to any harmful x-rays in use or even when calibrating or servicing.

The shelf – designated Q – deploys a low energy focussed x-ray source and a linear imaging array. The sample under test is scanned between the source and imaging array and a full picture built of the product. Additional images to give orthogonal data can be generated by turning the sample and rescanning as part of the regime parameters. Internal standards are used to calibrate the linear dimensions of the device giving a high degree of accuracy in measurement (better than 50 microns). The images formed are automatically analysed for dimensional characteristics and then saved for possible review at a later stage.

A significant feature of the Q shelf is that it produces an image for analysis in a matter of seconds and so is compatible with the philosophy of the Quantum Neo test station, providing information for process control immediately at the maker. In contrast a conventional CAT scanner used in the laboratory may take many minutes to produce an image.

How it works

To use the Q shelf the operator or supervisor is required to define a "brand" that has the nominal lengths of the segments entered with limits for the tolerance of these elements. It is also possible to enter the materials of each segment as this can be used for other features of the equipment such as the detection of voids.

Other information regarding construction can be entered such as the likely location of hidden capsules which can also be located by the x-ray system.

Once this brand data is entered and a stack regime selected)which defines what measurements are to be made and reported – the stack can also contain other physical measurements such as total length or PDV) the samples are entered into a hopper and the measurement started.

Each sample is tested automatically and the results displayed in the form of a report.

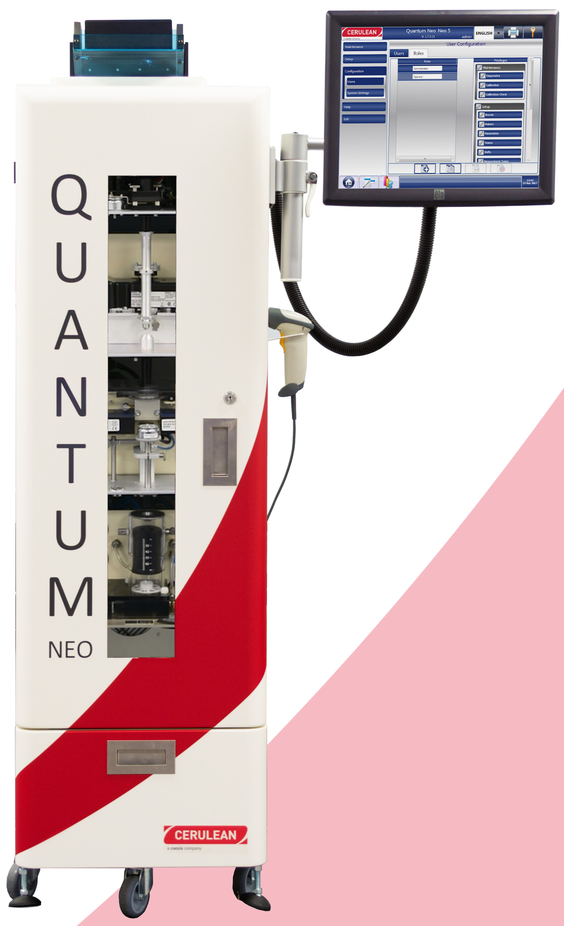

Fig. 1 Quantum Neo system

Experimental

THP devices that employ a carbon tip as a heat source were used for this test. A typical carbon tipped product is shown in figure 2.

These THP's can be complex devices and one consisting of 7 separate elements with two overwrap papers was used to demonstrate the consistency of measurement. In all 50 samples were measured and segment lengths and diameters automatically measured.

Results

Figure 2 shows and image of a typically complex THP product.

Measuring 5 batches of 10 rods provides a good measure of the individual segment lengths and diameters as well as the overall length and tipping length which can all be determined from the x-ray image.

The build consistency is shown in the attached table 1 which gives batch means and standard deviation for the whole batch of 50 rods.

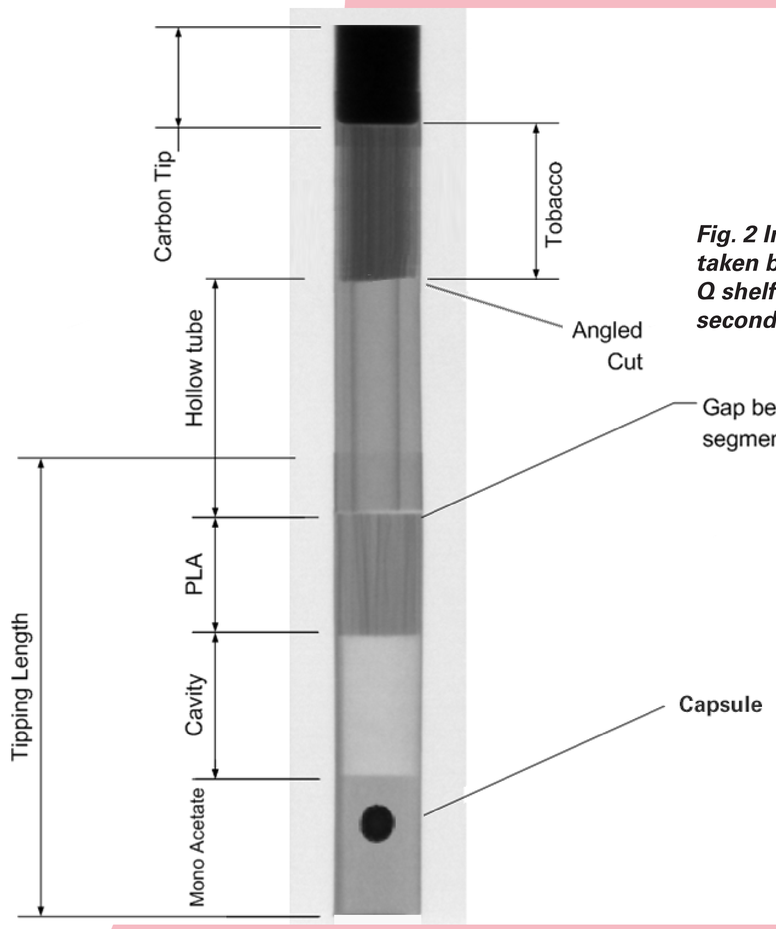

Fig. 2 Image of complex THP as taken by Cerulean Quantum Neo Q shelf – acquisition time <10 seconds.

Conclusions

Without deploying the Quantum Neo Q shelf it is not possible to determine the accuracy of build of these complex THP products without either destroying the products with the errors in measurement inherent in a deconstructed product or finding a method of examination that looks within the product.

The Quantum Neo has been shown to provide sufficient resolution for physical analysis of components within THPs using x-rays, the samples remaining undamaged by the process.

The novel use of a scanning system allows the system to be both automated, simpler and more affordable than complex, conventional CAT scanning devices.

	Length						
	Batch 1	Batch 2	Batch 3	Batch 4	Batch 5	Mean	stdev
Tipping	41.24	41.218	41.219	41.202	41.288	41.233	0.0334
Total	84.02	84.003	83.992	83.996	84.036	84.010	0.0183
Monoacetate	11.692	11.695	11.681	11.685	11.734	11.697	0.0211
Cavity	11.677	11.666	11.672	11.668	11.732	11.683	0.0276
PLA	12.240	12.227	12.238	12.251	12.236	12.238	0.0099
Hollow filter	25.786	25.792	25.787	25.809	25.811	25.798	0.0120
Tobacco	8.044	8.025	8.043	8.059	8.024	8.039	0.0147
Carbon	9.002	9.011	9.009	9.024	9.044	9.018	0.0165
Hollow filter	4.980	4.961	4.968	4.988	4.972	4.974	0.0106
	Diameter						
Monoacetate	7.775	7.811	7.722	7.759	7.801	7.774	0.0355
Cavity	7.811	7.837	7.743	7.765	7.797	7.791	0.0372
PLA	7.831	7.836	7.738	7.753	7.811	7.794	0.0454
Hollow filter	7.855	7.845	7.845	7.837	7.870	7.850	0.0127
Tobacco	7.882	7.916	7.882	7.906	7.860	7.889	0.0221
Carbon	7.756	7.758	7.747	7.776	7.731	7.754	0.0164
Hollow filter	7.843	7.829	7.855	7.864	7.819	7.842	0.0184

Table 1 Batch means and standard deviations for diameter and length of individual segments for 5 batches of 10 THP rods passed through the Quantum Neo Q shelf.

About Cerulean

Based in Milton Keynes, UK, Cerulean manufacture quality assurance test equipment for the tobacco industry.

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