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PRELIMINARY EVALUATION OF A COMMERCIALY AVAILABLE ELECTRIC AEROSOL INHALER FROM CHINA

OBJECTIVE: Provide a preliminary understanding of the design and features of a recently introduced electronic cigar (E-Cigar) that yields nicotine containing aerosol when puffed. Determine aerosol and nicotine yields for the E-Cigar under a set of machine smoking conditions that would help define puffing parameters that could be used for future studies.

SUMMARY: The commercially available electronic cigar from Beijing SBT RUYAN Technology & Development Co., Ltd, produces a heated aerosol containing tobacco extract and nicotine. The rechargeable battery is easily replaced, as is the cartridge containing the aerosol generating material (propylene glycol) and tobacco extract. The electronics contained within the cigar are such that heat is applied only during a puff, generating substantial amounts of aerosol. When compared to Eclipse cigarettes on a laboratory smoking machine using a modified Eclipse "intense" puffing regimen (22 puffs, 60ml, 3s duration, one puff every 30s), wet total particulate matter and nicotine yields were comparable. For the electronic cigar, one battery charge produced aerosol for almost 400 puffs, while the extract cartridge produced aerosol for over 600 puffs, the equivalent to more than 25 Eclipse cigarettes.

STATUS: This preliminary study is complete.

KEYWORDS: Electric cigar, pipe, aerosol, nicotine, propylene glycol, yield, PREP

Introduction: Beijing SBT RUYAN Technology & Development Co., Ltd (Abbr. RUYAN Tech.) is a subsidiary company, owned by the Hong Kong based SBT Corporation. Further information about the company and their products can be viewed at their website:

<http://www.sbtry.cn/rykj-en/jt-en.htm>.

In 2004, Ruyan Tech, introduced for commercial sale in the Chinese market a battery-operated electronic cigar capable of generating significant amounts of nicotine containing aerosol when puffed in the manner of a traditional tobacco burning cigar (see World Patent WO 2004/095955 (11.11.2004 Gazette 2004/46)). Two commercial versions of the device exist at this time, the Ruyan Atomizing Electronic Cigar and the Ruyan Atomizing Electronic Pipe. This report provides information on the electronic cigar.

A brief excerpt from their website describing the electric cigar follows (grammatical errors have not been corrected):

RUYAN ǁ ANI is a none-igniting substitute of the cigarette, it has some characteristics with the traditional cigarettes, such ad making you refresh, fulfilling the smokers' needs; But it has much more different with the traditional cigarettes substantially, such as no tar, no ignition, no 460 kinds of chemical substances that can lead to respiratory and cardiac system diseases, no the carcinogenic in the traditional cigarettes.. . .

So the smokers who use RUYAN@ANI will avoid tar and many dangerous substances to get into their lungs and bodies.

In addition, the instruction manual for the devices includes the following (taken from the manual for the electronic pipe):

The Ruyan atomizing electronic pipe is a nonflammable atomizing electronic pipe, which performs and carries the similar functions and features as the ordinary pipe. It produces a refreshing feeling and fulfills the smokers' addiction through the delivery of the senses of satisfaction and relaxation. Besides, the product also carries the functions as a smoke-quitting substitute. The major differences between the Ruyan atomizing electronic pipe and ordinary pipe are:

- 1. No tar or the harmful constituents to the human body, hence contains no carcinogenic compounds;**
- 2. No ignition required, hence will not lead to the production of more than 4,000 constituents from chemical reaction during ignition;**
- 3. No "second hand smoke" or environmental pollution;**
- 4. No possibility to cause fire. It can be used safely at fire prevention area;**
- 5. According to the smoke-quitting proposal, the target of quitting smoke can be reached non-painfully in a short period of time.**

The Reduced Risk and Applied Product Development group at RJRT purchased three electronic pipes and three electronic cigars though colleagues visiting China. The cigars and pipes were purchased for study in the laboratory in an effort to better understand the design of the products and how they function. The bulk of our work to date has been directed at understanding the electronic cigar.

Methods: One of the purchased cigars was carefully dissected in the QA Instrumentation Laboratory. Digital photos were taken throughout the process to document the construction of the cigar and to allow inferences to be made concerning the functions of the various components.

Another electronic cigar was studied in the smoke lab to determine aerosol yields when “smoked” on a modified Borgwaldt 20 port linear smoking machine. Since no defined smoking regimen exists for testing a device of this nature, we decided to test the aerosol yields from the electronic cigar using puffing parameters that have been used in the past to study Eclipse cigarettes. It was theorized that since the aerosol yield from the electronic cigar was in all likelihood closer in composition to the smoke yielded from Eclipse cigarettes than the smoke yielded from tobacco burning cigarettes, using puffing parameters that have been associated with Eclipse cigarettes could provide a foundation for making future comparisons.

To maximize the potential aerosol yield from the electronic cigar, we decided that using the puffing parameters associated with the Eclipse “intense” puffing regimen would be used. The Eclipse “intense” puffing regimen consists of 22 puffs, 60ml volume, with each puff lasting 2 seconds. One puff is taken every 30 seconds until the final puff is taken. This puffing regimen is typically referred to via the shorthand descriptor “60/30/2”.

After some initial attempts to measure aerosol yield from the electric cigar, it was determined that under the 60/30/2 puffing regimen, yields were relatively low. In some informal tests, we determined that by increasing the puff duration by 1 second, (i.e. 60/30/3), aerosol yields from the electronic cigar increased dramatically. Data from both 60/30/2 and 60/30/3 regimens are presented in the Results section (below).

Results:

Anatomy of the Electronic Cigar - One of the electronic cigars was carefully dissected in the QA laboratory in an effort to 1) identify as many of the individual components as possible; 2) document the design of the cigar; and 3) infer as much as possible concerning how the cigar functions. A collection of digital photographs were taken and are available for viewing at: (<file:///wpbasisp1/rdlibrary/report/R015/R015631A.PDF>). A small subset of the photos will be included in this report to facilitate understanding of the design of the electronic cigar.

Figure 1 depicts the electronic cigar and accessories in the original retail box. Included along with the electronic cigar (A) are: a battery charger (B); two lithium rechargeable batteries (4.2V) that seem identical in physical size to standard AAA batteries (C); and two plastic covers that fit tightly over the mouthpiece of the electronic cigar when the cigar is not in use to keep the mouth end of the cigar from getting soiled (D).



Figure 1

Figure 2 shows the fully assembled cigar as it would be used by the smoker. The cigar body is round, except for the flattened mouthpiece. Approximate size of the assembled cigar is 146mm long with a diameter of 13mm.

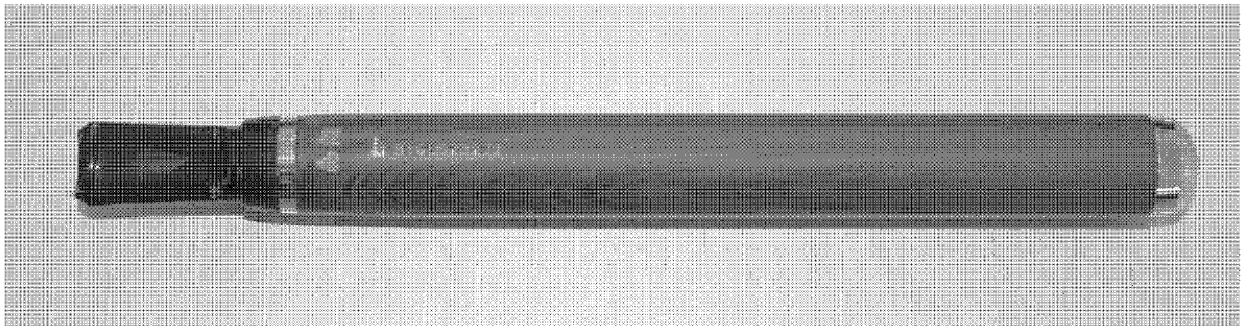


Figure 2

In Figure 3, the mouthpiece/extract cartridge unit (B) and the front-end plastic “widow” (C) have been separated from the cigar body (A). Parts B & C, are designed to be easily removed from the body of the electronic cigar by un-screwing from the threaded gold rings (D). For a detailed description of the mouthpiece/extract cartridge see Moore, 2006 (ACD-M DSM 2006, 142A).

The mouthpiece/extract cartridge unit is designed to be periodically replaced with a new unit when aerosol levels from the cigar diminish. The plastic window is easily removed to allow a discharged battery to be replaced with a freshly charged battery (E). The gold colored rings (D) are normally permanently glued to the inside of the cigar body and can also serve as contact points for the electrical circuitry (note solder drop on forward ring [arrow]). Finally, a small hole in the cigar body provides access to a reset contact for the electronic circuit (F).

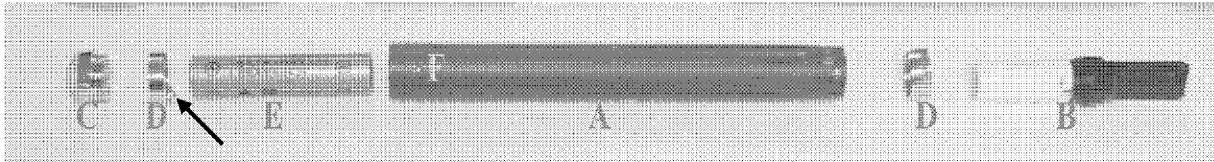


Figure 3

The stainless steel sleeve or main body of the electronic cigar (component A in picture above) was cut longitudinally to expose the interior and allow access to the internal components (Figure 4).

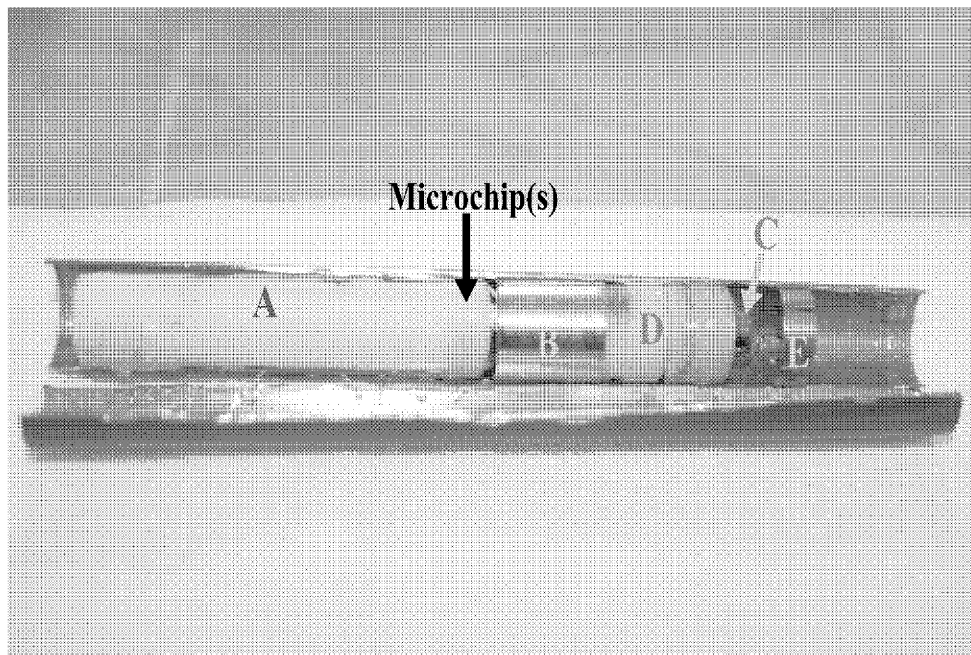


Figure 4

The interior of the electronic cigar body (Figure 4) houses the battery holder (A) and the micro chip(s) controlling the electronic circuitry (black arrow), a stainless steel ring (B), the two heater elements (one contained within the steel ring, the other nearest the mouth end of the cigar (C) and the air-flow sensor switch (internal to D). Metal ring E appears to be inserted for structural support to maintain the shape of the electronic cigar where the extract cartridge is inserted to

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