Method and Apparatus for the Collection and Analysis of Viscous Fluids

Introduction

While many methods and associated tools exist for the collection and analysis of fluids and are known to those skilled in the art, disclosed herein is a novel method and apparatus intended for use with viscous fluids.

This disclosure enables rapid collection, transfer and analysis in spite of the slow flowing and cumbersome nature of viscous fluids. This method delivers a quick result, often in a matter of seconds or minutes.

Among the many methods for analysis are those that deliver a color change (colorimetric), a change in fluorescence (fluorometric), a change of electrical signal produced by the chemical reaction (electrochemical) or a change in the electromagnetic permittivity of the fluid at some wavelength (electromagnetic).

The fluids to be collected and analyzed may be of a biological source, such as semen or saliva, or related to an industrial process, such as a motor oil or a beverage concentrate. The chemical process is different in each case. However, this disclosure enables easy handling of the fluid and optimal exposure of the fluid to the chemical agents or sensors of the analysis.

The separation of the collection tool from the analysis tool permits the use of chemistries or methods (heat or UV light for example) that cannot or should not come into contact with the source of the viscous fluid. In the case of samples from humans or animals, chemistries that are unsuitable for human or animal contact can be used.

The apparatus can be cleaned and reused if the chemical or sensing method lends itself to that. In this case the material used to manufacture the apparatus can be of a more permanent nature provided that the functionality is retained. But the simplicity and low cost of manufacture permit this apparatus to be used once and discarded. For the purposes of this disclosure the material is assumed to be a paper or polymer-based material.

Collection of a Viscous Fluid

Figure 1 shows a paper or polymer collection strip (2) that is wide enough to deposit the fluid sample and long enough to be easily handled. The strip is thick enough to be rigid and made of a material that does react with the fluid.

The sample to be analyzed (1) is placed at one end of the strip. The fluid must be of high enough viscosity to remain in place on the strip for the transfer.

Transfer to Test Card

Figure 2 shows a paper or polymer test card (3) that contains the chemistry or sensing capability at (5). Adjacent to this is a slit in the square (6). This slit is of a width equal to or slightly greater than the thickness of the strip (2). (4) indicates a score line to facilitate folding the test card later if needed.

In Figure 4 is shown the other end of the collection strip (11), as it is inserted into the slit (10) on the test card (9) and the strip is drawn completely through the slot.

Once the collection strip is completely drawn through the slit (13) in Figure 5 the sample fluid (13) is deposited on the test card in contact with the chemistry (12). Some residue (14) may remain on the collection strip.

The dimensions of the strip and the dimensions of the slot are designed such that a good fit enables easy insertion as well as a snug fit to prevent leakage and enable efficient transfer. This is shown in the cross-section view of the test card (7) in Figure 3 where the length of the slit (8) must accommodate the collection strip while the width of the slit must maintain a snug fit so that the sample fluid is transferred from the strip to the card.

The test card (3) is made of a material that is compatible with the goals of a specific test and which is also able to receive the deposition of the chemical formulation on its surface that will enter into a reaction with the sample fluid. This chemical formulation in dry or immobilized form is shown as (5). The thickness of the test card is such that it is adequately rigid for easy handling but still easily foldable if folding is a requirement for a specific test.

Fold

The test card (3) is scored along the line (4). The test card can be folded in along this line such that the sample fluid (13) and the chemistry (12) are enclosed in the folded test card. By completely folding the card, the sample fluid (13) which is viscous is distributed over the area containing the chemistry (12). This optional step creates a thinner film of sample fluid which may be useful for some tests.

Measure

At the appropriate time for a specific analysis, the measurement is performed. The test card if previously folded may be unfolded if that is needed for a specific test.

If the measurement is colorimetric and relies on ambient light then the test card may be inserted into a frame once unfolded to maintain the card flat for best results. Alternatively, the test card may be made of a material that has shape memory and returns to the flat state when unfolded.

If the measurement is fluorometric then the test card may be manufactured from a translucent or transparent material that admits light at the excitation wavelength of the fluorescent component of the chemistry such that illumination from behind the test card at that wavelength will permit the needed fluorescent measurement.

If the measurement is electrochemical then the area (12) where the chemical reaction occurs may be embedded with sensors and electrical circuits that lead to a device that can measure the signal.

If the measurement is electromagnetic then the test card may be inserted into an appropriate device such that the area (12) can be measured.

Discussion

The collection of the fluid on one surface and the transfer to another as disclosed here makes it possible to easily position the viscous fluid opposite the chemistry. This is useful in cases where the fluid cannot be easily and accurately positioned otherwise. The handling of small amounts of viscous fluid is often clumsy as the fluid does not flow easily. Methods where the fluid is absorbed into a porous matrix such as absorbent paper or cotton wool require a later additional step of extraction of the sample fluid from that porous matrix. This also adds the possibility of contamination or modification of the fluid by the porous matrix. If the porous matrix preferentially retains some components in the fluid then the accuracy of the test can be compromised.

The test card is manufactured from a material that does not react with the sample fluid or reacts in a manner that is consistent with the goals of the specific test. Furthermore, it is desirable that the test card surface has limited or no porosity to the sample fluid (13). If not then the porous nature of the material can lead to modification of the sample fluid as set out in the previous paragraph.

Furthermore, when the chemical formulation is entirely on the surface the entire amount of chemical reagent or sensing capability is available to react with the sample fluid. This may lead to a reduced amount of reagent needed and a reduction in cost.

Since the paper or polymer surface of the test card is not perfectly smooth the chemical formulation can fill the microscopic imperfections to adhere to the test card. Suitable additives to enhance adhesion and/or form a film can be also included in a specific chemical formulation as will be readily seen by those skilled in the art.

Since the porosity is limited, the chemical reaction takes place with all or most of the sample fluid (13) and chemistry (12) on the surface of the test card (3) and in contact. This leads to less variability in the obtained result.

The test card may also carry printed information in peripheral areas such as lot number, test type, expiry date, markings for image analysis of a captured picture, temperature or humidity-sensitive markings, colors for matching with a colorimetric test, as well as product and manufacturer information.

It may also be useful to add to the test card a second area in the periphery with the same dried chemistry that does not get exposed to the fluid. When measuring, the comparison between the dry and the fluid results may be useful in some test scenarios.

It is anticipated that the test card may require special storage conditions, dependent upon the specific test. Humidity can be controlled with dessicant or a moist pad within a sealed wrapper. Temperature can be controlled with labelling regarding the required temperature range for storage and/or an indicator of a type known to those skilled in the art that reveals a deviation from required storage temperature at some point.

A secondary indicator test that reveals the moisture level, degree of oxidation or temperature history may be added to a region of the test card (3).

Figure 1

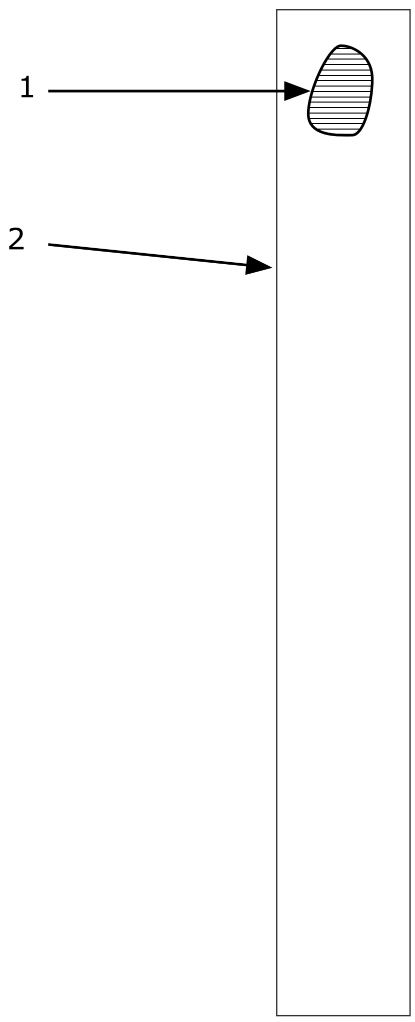

Figure 2

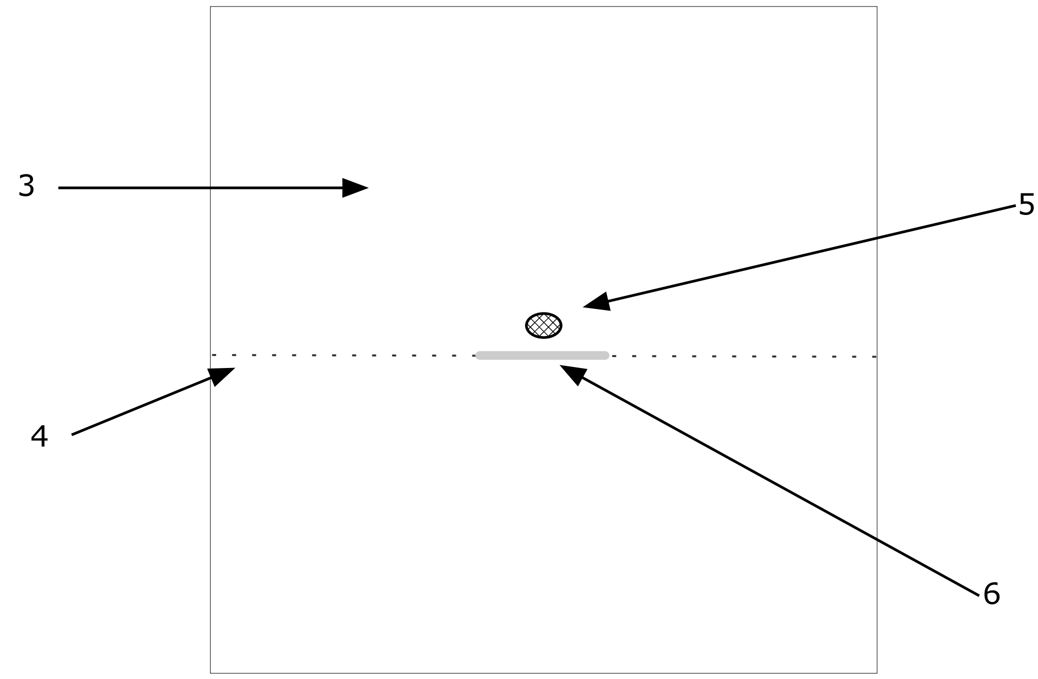

Figure 3

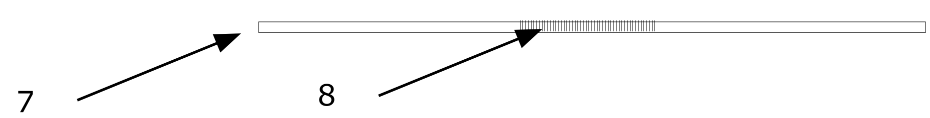

Figure 4

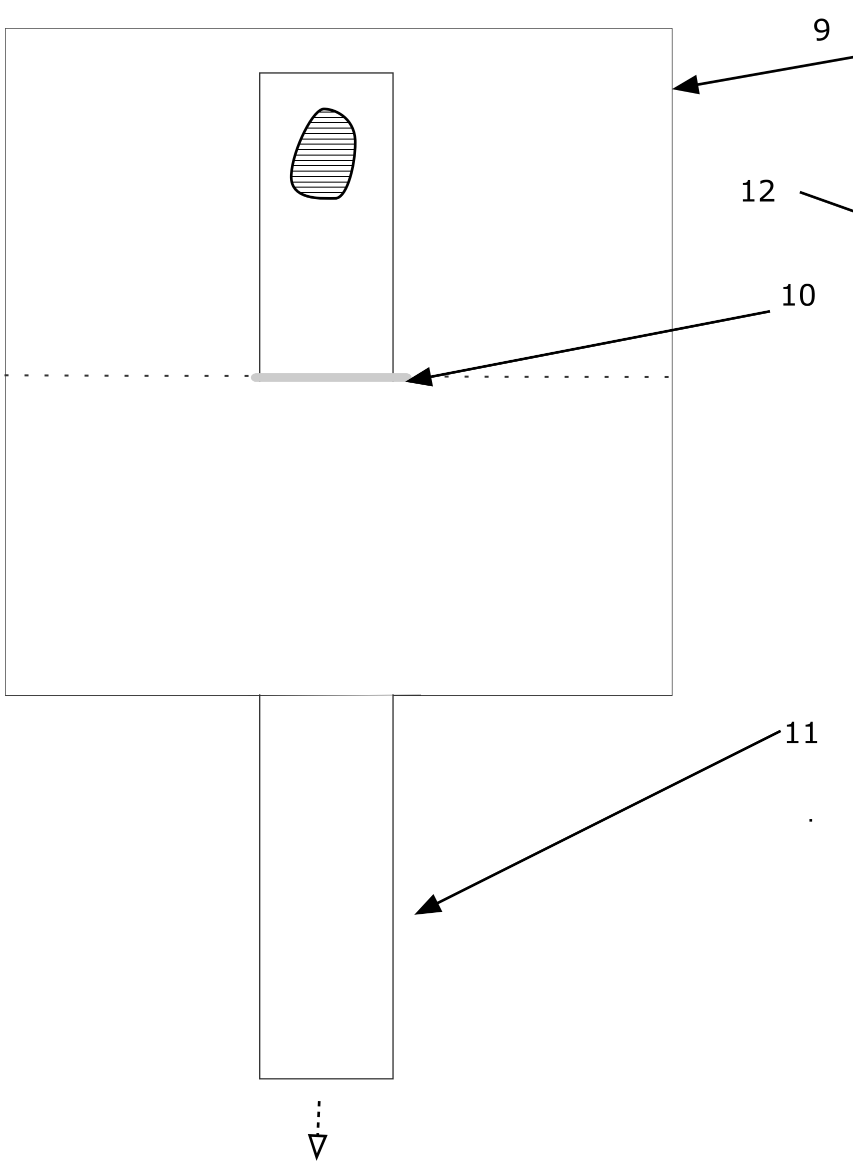

Figure 5